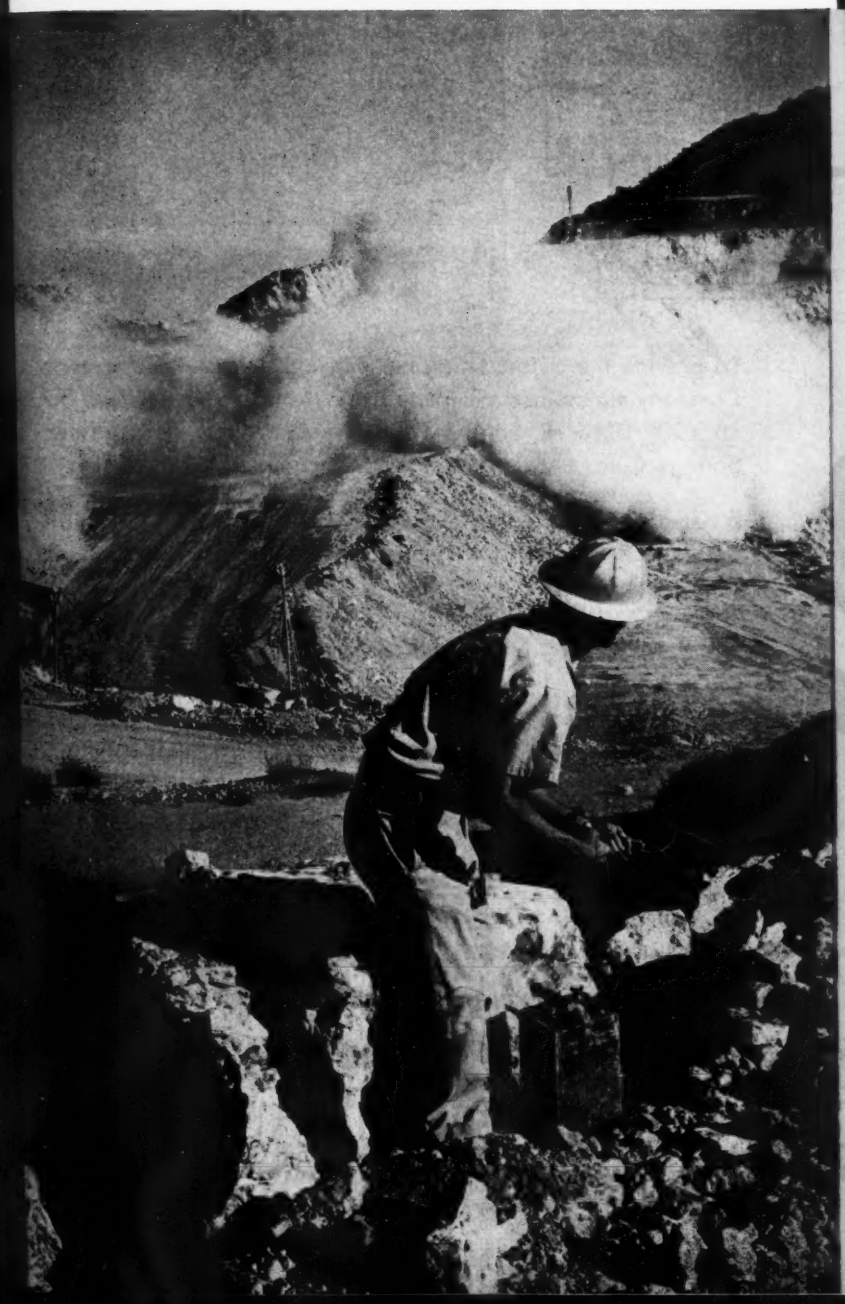
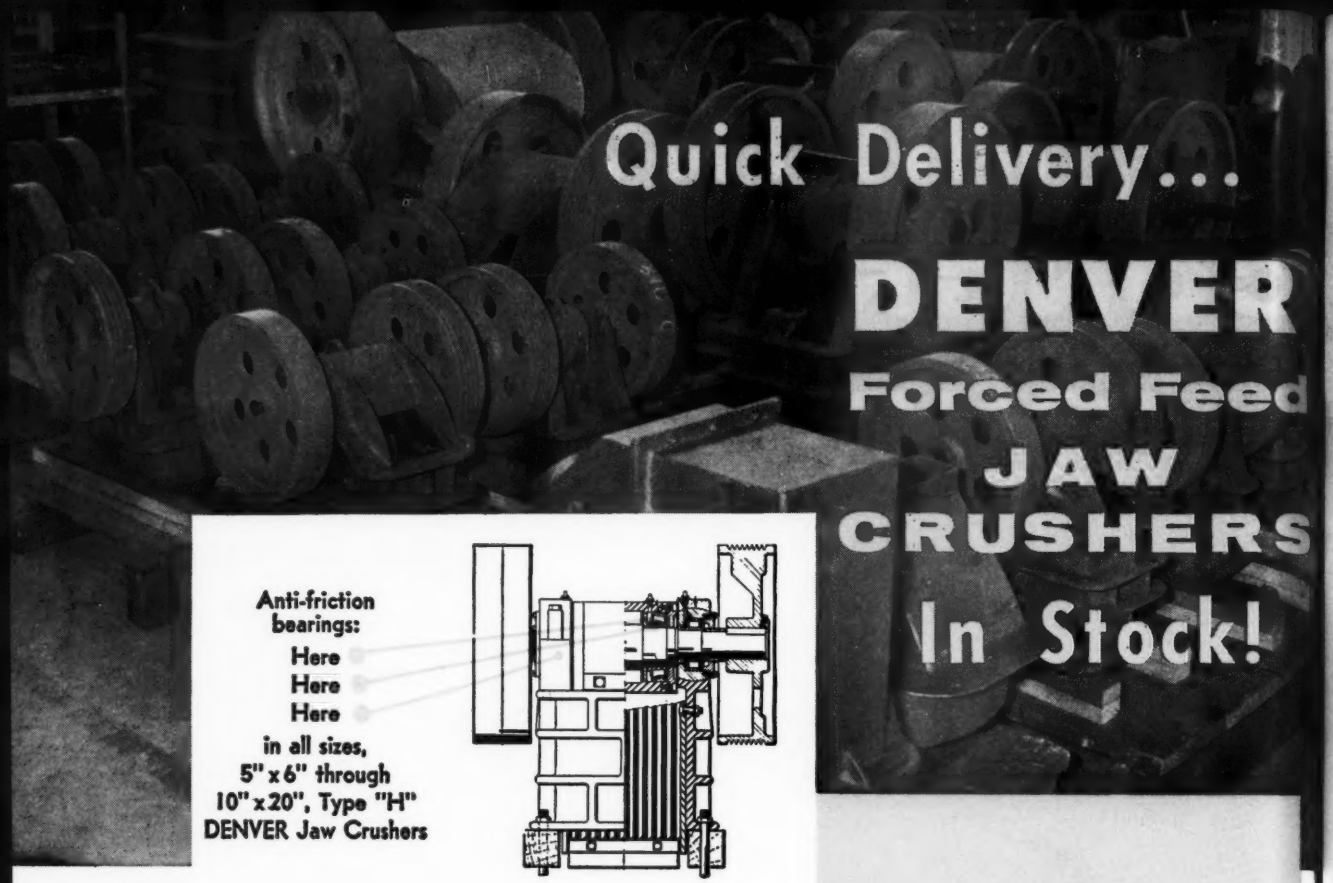
MINING CONGRESS JOURNAL

JULY 1958



IN THIS ISSUE . . .

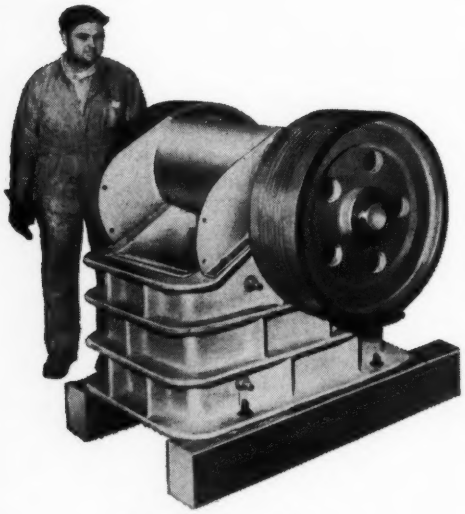
- Stripping Practices
- Industrial Minerals
- Pumping Solids
- Avoiding Rockbursts
- Roof Support
- DSM Screen
- A-C Mining Machinery
- Ammonium Nitrate Blasting



Quick Delivery...

DENVER Forced Feed JAW CRUSHERS In Stock!

Anti-friction bearings:
Here
Here
Here
in all sizes, 5" x 6" through 10" x 20", Type "H" DENVER Jaw Crushers



Shipment from stock in sizes 5"x 6", 8"x 10", 10"x 16" and 10"x 20". Other sizes to 36" x 48" are available.

Dealer Inquiries Invited

To provide the quickest possible delivery, DENVER Equipment Company maintains a complete stock of all sizes from 5"x 6" to 10"x 20" DENVER Forced Feed Jaw Crushers in Colorado Springs, Colo. Also, dealer stocks in many parts of the country.

A telephone call brings action to solve your size reduction problem. Recommendations, specifications, prices on request.

Now—Roller Bearings Throughout... for Long Life, Low Maintenance Cost

- Anti-friction roller bearings in side frame and bumper. Crusher runs smoother, bearings last longer, maintenance costs reduced.
- Side bearings in carrier permits bumper removal without exposing bearings to dirt.
- Side bearings on 10"x 16" and 10" by 20" sizes set in ball and socket type mounting for perfect self-alignment.
- Reinforced cast steel frame ends breakage.
- Manganese steel jaw and cheek plates for extra long service.
- Jaw plates reversible for long service, low maintenance costs.
- Pressure grease lubrication and labyrinth dust seals.

"The firm that makes its friends happier, healthier and wealthier"

DECO ENGINEERS — DENVER EQUIPMENT 24 HOUR SERVICE COMPANY — Complete Mill Equipment

DENVER EQUIPMENT COMPANY

1400 Seventeenth St. • Denver 17, Colorado

- DENVER
- NEW YORK
- TORONTO
- VANCOUVER
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- LONDON
- JOHANNESBURG

MINING CONGRESS JOURNAL

VOLUME 44 JULY 1958 NUMBER 7

CONTENTS

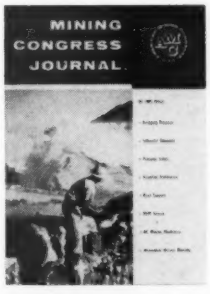
Opinions expressed by authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

ARTICLES

DEPARTMENTS

OUR COVER

FIRE IN THE HOLE! Blasting at Asarco's Silver Bell, Arizona, mine.



Member
Audit Bureau of Circulation

Indexed regularly by Engineering Index, Inc.

More tonnage . . . more profits

50% Higher Tonnage with the *new* CM37

For medium and high seams

Backed by the tried and proven cutting principle of the original Lee-Norse Miners, the CM37 brings a new high in operational efficiency to continuous mining. This rugged machine has more power, more capacity and higher tramming speed that results in increased tonnage per man shift.

Check these NEW FEATURES!

- Total weight 25 tons—a 25% increase! Extra weight mostly in improved cutter head where it does the most good!
- More power—fewer motors! Only 3 identical electric motors used . . . conservative continuous ratings . . . no water cooling.
- Heavy duty electric control.
- 14" wide crawler treads with improved hydraulic motor and gearing.
- 24" wide conveyor driven by hydraulic gear motors applied directly to gathering head. Hydraulic start and stop . . . no clutch required.
- Multiple tramming speeds—variable speeds to 50 feet per minute . . . fast tramming at 90-100 feet per minute.
- Increased capacity...4 to 5 TONS PER MINUTE.

Coal high or low? . . .

. . . with Lee-Norse MINERS

For Low Coal . . .

LCM28

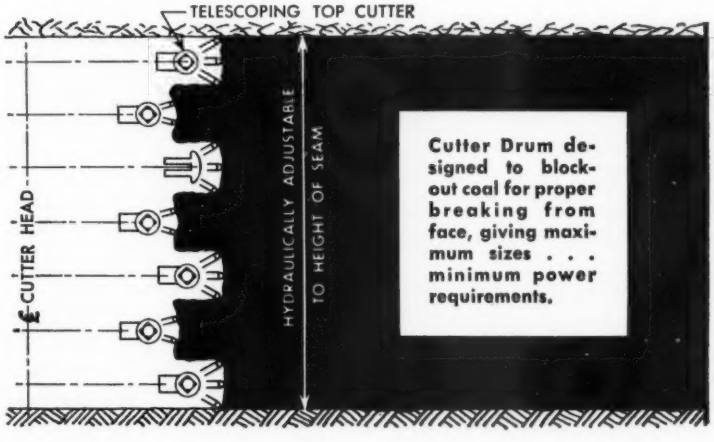
ready for production!

For seams 30" to 48"

Here's how LCM28 *produces profitable tonnage!*

1. Weight 16 tons — rugged and heavy enough to cope with tough cutting conditions.
2. Capacity—2 to 3 tons per minute.
3. Hydraulically driven 24" flexible Conveyor.
4. Two Cutter Heads cut a wide face 16 feet or less.
5. Dual gathering arms have maximum reach of 11 feet . . . will gather ALL the coal regardless of position.
6. Controlled Tramming Speed gives proper sumping action and Dual Pump combination gives high tramming speed.
7. Especially good in cross-cut development!

The LCM28 "Low Coal" Miner employs a new combination of cutting and gathering coal. The vertical mounted extendable cutter drums arc together like a "clam shell."



All Lee-Norse Miners are available in AC or DC power.

Lee-Norse Company
CHARLEROI, PENNA.
Specialists in Coal Mining Equipment

Lee-Norse MINERS keep production on the go!

Gibraltar Coal Uses Bucyrus-Erie Teamwork To Keep Coal Moving . . . *You Can, Too!*

Two Bucyrus-Erie 190-Bs team up to speed coal removal at the Gibralter Coal Corp. mine near Central City, Ky. While a 190-B stripping shovel with 6-yd. dipper removes overburden, a 190-B coal loader with 10-yd. dipper transfers coal to the hauling units.

It's an unbeatable team. The advanced design of these machines assures not only high daily production, but the month-after-month dependability that sustained big output requires.

Modern front end combines great strength with light weight to boost payload ratio. Heavy-duty construction throughout keeps these shovels working, holds down maintenance, assures long life. Bucyrus-Erie improved Ward Leonard variable-voltage control permits fast acceleration and deceleration, provides extra torque when needed for fast work cycles.

Let us tell you more about the proved dependability and big output of Bucyrus-Erie electric shovels. Write for full information. Bucyrus-Erie Company, South Milwaukee, Wis. 177158

A Familiar Sign . . . BUCYRUS ERIE *. . at Scenes of Progress*

NOW! A

REMOVABLE AIR-LEG BIT THAT'S ONE-PIECE STRONG

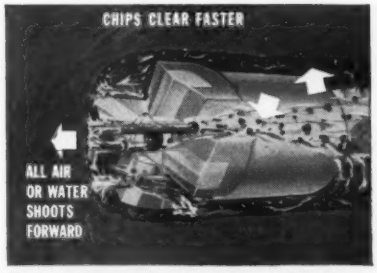
IT'S removable—yet the new Timken® tapered socket bit for air-leg drills is one-piece strong. With this tapered union, you get all the advantages of removability, and the strength of one-piece steel.

Removability of the new Timken tapered socket bit gives you all these advantages you can't get with intraset steels:

1) No need to throw away good drill steel when the carbides wear out. With intrasets you have to throw away good steels. 2) A pocketful of bits is enough for a day's work. You haul an armful of steel with intrasets. 3) You can change bit gauge sizes fast on the same steel. Using intrasets, you have to change the whole steel. 4) You carry only the bit to the shop for resharpening. With intrasets you lug the whole steel. 5) You get longer gauge wear because there are four carbide cutting edges. Most intrasets have only two.

The new Timken tapered bit's new frontal design features clear chips faster (right). And you get superior wear-resistance with added shock-resistance because of new special-analysis carbide inserts. They can be reconditioned many times.

To get removability *plus* strength, get the new Timken tapered bit. For free brochure, write The Timken Roller Bearing Company, Rock Bit Division, Canton 6, Ohio. Cable address: "TIMROSCO".



CHIPS CLEAR FASTER because 1) five front holes shoot water or air directly against the rock face and 2) deeper, wider wing clearance lets chips wash back faster.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

AVAILABLE NOW!

THE AIR-LEG BIT OF THE FUTURE

WALKER WORKS 'ROUND-THE-CLOCK UNCOVERING BAUXITE . . .

MARION

POWER SHOVEL COMPANY

MARION, OHIO, U. S. A.

A Division of Universal Marion Corp.

Marion manufacturers a complete line of excavators from ¾ to 75 cubic yards

This Marion 7400 walking dragline is a dependable performer for its owner—a large aluminum company. It works 'round-the-clock, five days a week stripping overburden and stacking it in previous cuts as backfill. The overburden is 60′ to 150′, consisting of sand, gravel, lignite and clay. The walker is equipped with a 200-foot boom that carries a 10-yard bucket. Location of the bauxite mine is in Arkansas.

Consult Marion Mining Specialists for Lowest Costs on Your Property.

27 ton

"EUC" REAR-DUMP

It's new...but JOB PROVED!

325 or 335 h.p....Torqmatic Drive...18.00 x 25 tires

Model R-27 is a new size in the complete line of Euclid Rear-Dumps—rated payload is 54,000 lbs. This off-highway hauler incorporates the job-proved components which have made Euclid Rear-Dumps the outstanding choice of contractors, mines and quarries.

With either 325 h.p. GM diesel or 335 Cummins engine, Allison Torqmatic Drive makes maximum use of the power for faster hauling cycles. Converter lock-up in the 4-speed Torqmatic permits 34 mph speed with full payload and efficient performance on long, high speed hauls.

Standard 18.00 x 25 tires on all four wheels assure the traction and load carrying capacity needed for moving 27-ton payloads on tough hauls. Standard body is rated at 18 cu. yds. struck —quarry type body is also available. The R-27 is equipped with oil retarder for safer, more economical braking on jobs with steep down-grades on the loaded haul.

See your Euclid dealer for detailed specifications on this new 27-ton Rear-Dump . . . it's a good example of the advanced design that makes Euclid your best equipment investment.

EUCLID DIVISION GENERAL MOTORS CORPORATION, Cleveland 17, Ohio

A complete line of Rear-Dumps—10, 15, 18, 22, 27, 40 and 50 ton capacities, also semi-trailer models of 12, 22 and 35 ton payload—to fit any job.

GM GENERAL MOTORS EUCLID

EUCLID EQUIPMENT

FOR MOVING EARTH, ROCK, COAL AND ORE

Short-lived screens shoot holes in your profits

When you're screening hard, extremely abrasive materials by the ton, you want a screen that will *last*. Frequent screen failures mean frequent work stoppages for repairs or replacements . . . and that means higher cost-per-ton of material screened. To hold downtime to a minimum, specify screens that are "tailor-made" for long service life . . . CF&I Space Screens.

The steel in each CF&I Space Screen is chosen in accordance with its ability to perform under the specific conditions found on the job . . . for its excellence in resisting abrasion . . . vibration . . . fatigue, or any combination of these factors. Throughout every production step—from blast furnace to wire drawing and weaving—CF&I's careful quality-control procedures ensure long-lasting, accurate screening. And CF&I offers a wide range of screening specifications (see table) to satisfy various job requirements.

For prompt dependable service, complete information or engineering assistance, contact the CF&I sales office nearest you.

WEAVES
DOUBLE CRIMP—heavy screens, long life under toughest operating conditions
LOCK MESH—very accurate sizing
FLAT WEAVE—least resistance to material flow
OPENINGS
LONG SLOT—relieves blinding and clogging
RECTANGULAR—maximum throughput
SPECIFICATIONS
WIRE SIZE—.035″ to 1″ diameter; clear openings .063″ to 6″

6119-B

Cut Downtime WITH CF&I **SPACE SCREENS**

THE COLORADO FUEL AND IRON CORPORATION

In the East: **WICKWIRE SPENCER STEEL DIVISION** — Atlanta • Boston • Buffalo • Chicago • Detroit • New Orleans • New York • Philadelphia

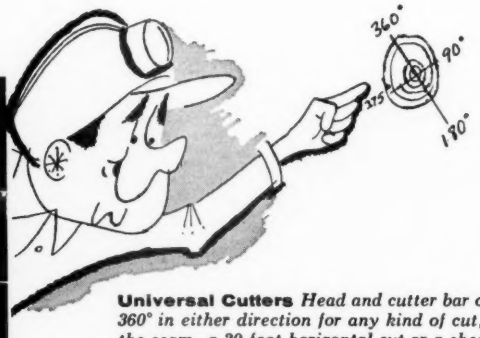
In the West: **THE COLORADO FUEL AND IRON CORPORATION**—Albuquerque • Amarillo • Billings • Boise • Butte • Denver • El Paso • Ft. Worth • Houston • Lincoln Los Angeles • Oakland • Oklahoma City • Phoenix • Portland • Pueblo • Salt Lake City • San Antonio • San Francisco • San Leandro • Seattle • Spokane • Wichita

CF&I OFFICE IN CANADA: Montreal • **CANADIAN REPRESENTATIVES AT:** Calgary • Edmonton • Vancouver • Winnipeg

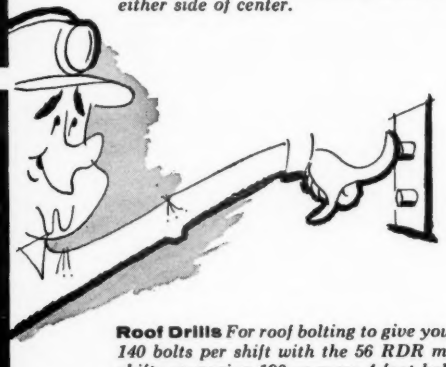
you can have an

...with Jeffrey

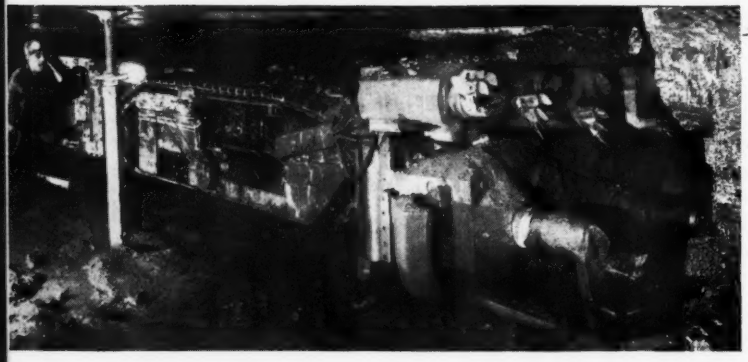
Alternating current power, with its many operating advantages, can now be employed throughout the electrified mine. All Jeffrey machinery, from cutters at the working face to the main belt carrying coal above ground, can be powered by AC as well as DC.

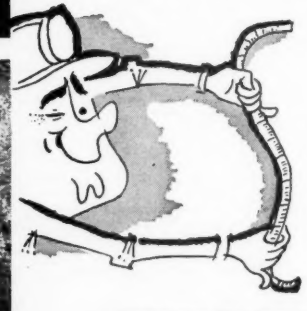


Universal Cutters *Head and cutter bar can be rotated 360° in either direction for any kind of cut, any place in the seam—a 30-foot horizontal cut or a shearing cut 5'5" either side of center.*



Roof Drills *For roof bolting to give you increased safety. 140 bolts per shift with the 56 RDR machines . . . some shifts averaging 190 or more 4-foot bolts.*



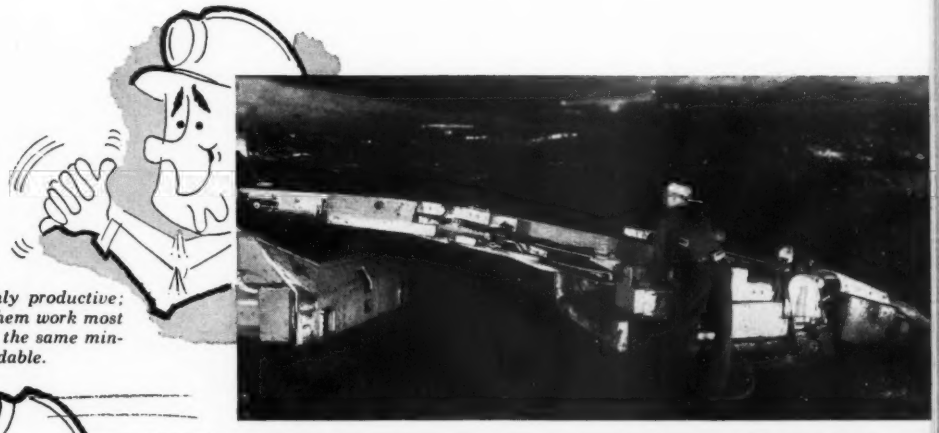


Colmols *For low, medium or high seams, Jeffrey Colmols offer the ultimate in mechanized mining. Coal is broken from the face, not ripped or ground off. You get better overall screen consist, greater speed and efficiency. Withstands the most severe operating conditions.*

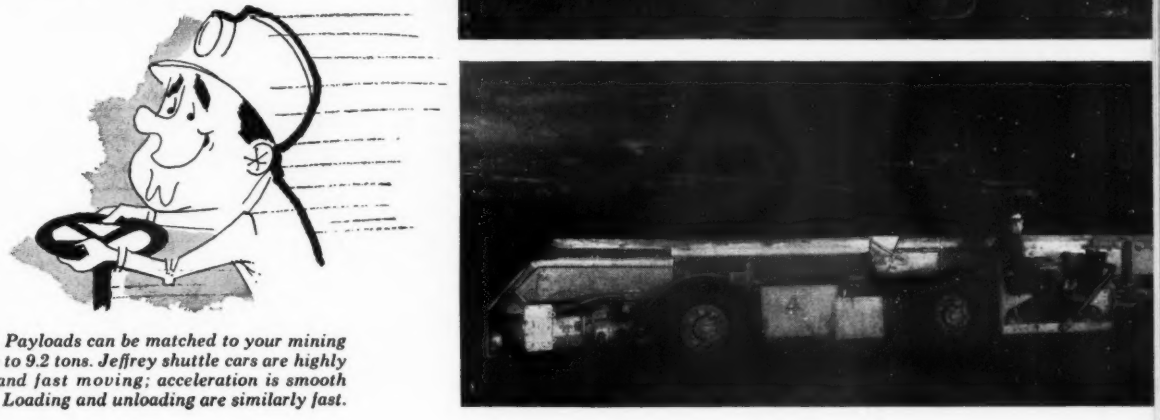
all-AC-powered mine

equipment

Production goes up with Jeffrey machinery in your mine. Maintenance is low. The reason... 80 years of world-wide experience applied to the development of mining and materials-handling equipment.



Loaders *Fast, easily maneuvered, highly productive; flexibility built into Jeffrey loaders lets them work most efficiently with other face equipment and the same mining cycle. Time-tested and proven dependable.*



Shuttle Cars *Payloads can be matched to your mining height: 4.6 tons to 9.2 tons. Jeffrey shuttle cars are highly maneuverable and fast moving; acceleration is smooth and automatic. Loading and unloading are similarly fast.*

Let a Jeffrey engineer show you how to reduce costs with Jeffrey mining machinery and handling equipment. Call our nearest office. The Jeffrey Manufacturing Company, 958 North Fourth St., Columbus 16, Ohio.

TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

JEFFREY

0.5 seconds

1.0 seconds

1.5 seconds

The little puff of smoke in the foreground is a signal bomb for the photographer

2.0 seconds

3.5 seconds

7.0 seconds

2,750,000 pounds of Du Pont "Nitramex®" 2H Removes Ripple Rock

Why it was chosen for this biggest of all blasts . . .

For Its Safety—The inherent safety of blasting agents helped win the nod for "Nitramex" 2H over conventional dynamites for a complex coyote blast of this sort.

For Handling Convenience and Water Resistance—Packed in hermetically sealed metal containers easily carried and stacked, and producing no headache from handling, "Nitramex" 2H was a natural.

For Strength—Plenty of energy was needed to knock off two underwater peaks, and "Nitramex" 2H supplies power equal to 80% Gelatin, higher than any other blasting agent.

For High Density—The blast required extremely heavy charges. "Nitramex" 2H, with the highest density of any commercial explosive, insured getting the required loads where they were needed regardless of size of coyote.

For Shattering Power—The high velocity and power of "Nitramex" 2H was needed to insure adequate breakage and dispersal of rock in order to provide required channel depth without dredging.

Your Du Pont Explosives representative can show you a Du Pont Blasting Agent that can improve *your* blasting. E. I. du Pont de Nemours & Co. (Inc.), Explosives Department, Wilmington 98, Delaware.

DU PONT BLASTING AGENTS

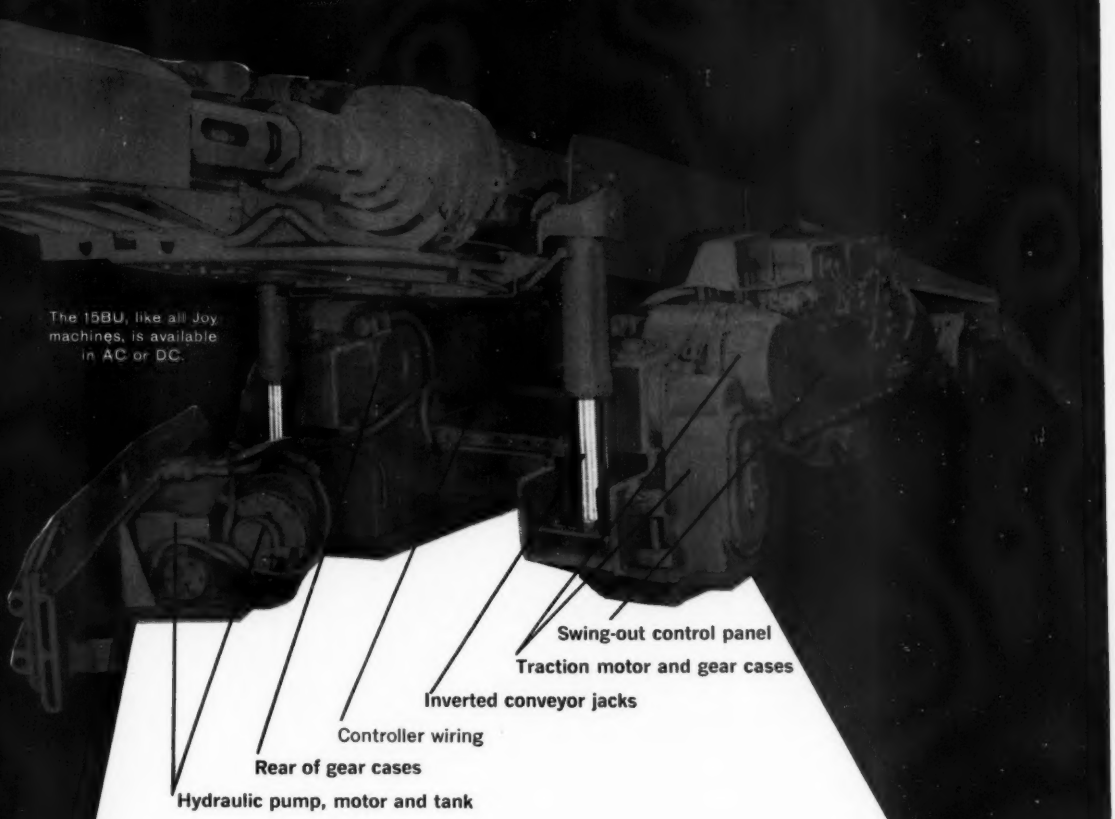
DU PONT
REG. U.S. PAT. OFF.

Blasting Supplies and Accessories

Better Things for Better Living . . . *through Chemistry*

new JOY 15BU LOADS 15 TONS PER MINUTE

HAS "swing-out" SERVICE PANELS



REAL ACCESSIBILITY TO ALL OPERATING AND CONTROL MECHANISMS . . . A JOY FIRST!

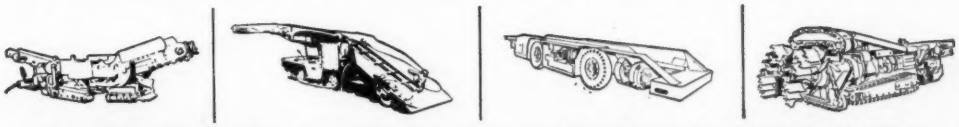
For the first time, all sections requiring regular inspection, servicing or maintenance can be reached from the outside. The hydraulic pump, motor and oil tank are mounted on the swing-out bumper. The electrical control panels swing open with all controls mounted on the inside of the hinged cover plate. And, all motors and drives are mounted outside the frame.

This easy, fast servicing, together with quick, responsive, high-tonnage operation, gives you the chance to make a substantial reduction in costs-per-ton . . . the savings you need to maintain or increase your profit margin today.

The 15BU is just one of many new machines designed by Joy for faster, more efficient mining . . . the result of a continuing program of research and development. **Joy Manufacturing Company,** Oliver Building, Pittsburgh 22, Pa. In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario.

WRITE FOR BULLETIN 233A-3

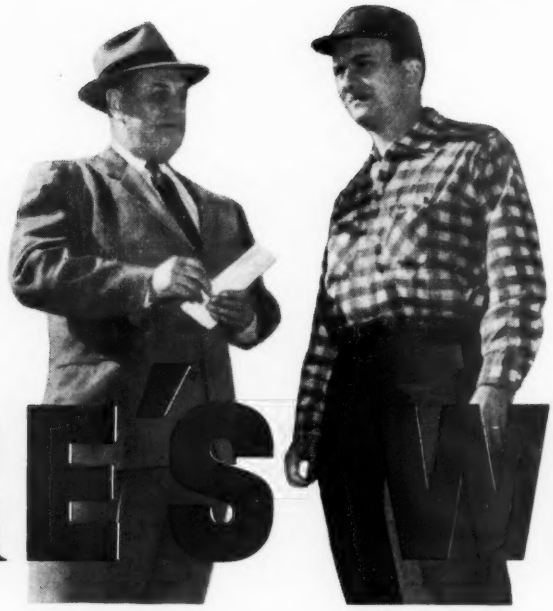
JOY EQUIPMENT FOR MINING . . . FOR ALL INDUSTRY



CONTINUOUS MINERS, MOBILE LOADERS, SHUTTLE CARS, COAL CUTTERS, CUTTING MACHINE TRUCKS, COAL DRILLS, CONVEYORS, TIMBER SETTERS, SHUTTLE CAR ELEVATORS, BELT FEEDERS, FANS, BITS, PORTABLE BLOWERS, COMPRESSORS ROCK DRILLS, HOISTS, CORE DRILLS

W&W CL7045-233

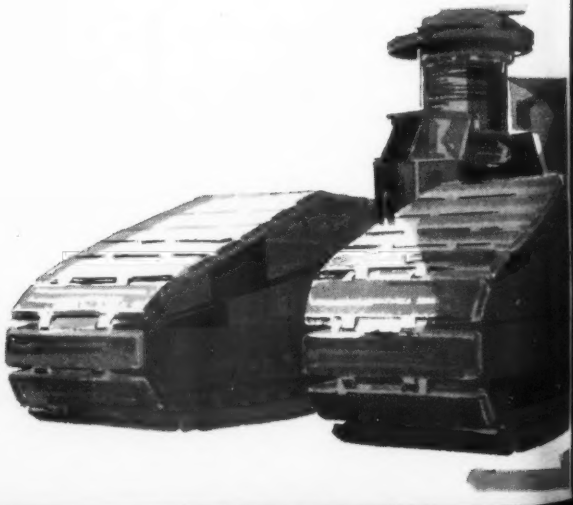
Big Paul, 70-cubic-yard shovel at River King mine, is 12 stories high.



Bob Kelce, assistant mine superintendent, gets quick run-down on lubrication situation from Standard's Hervie Dillingham.

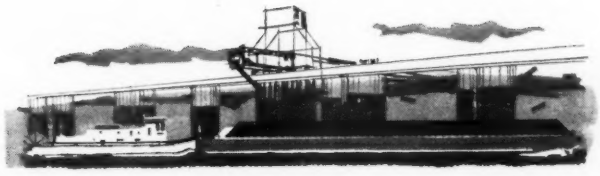
HERE'S WHY

River King mine chose STANDARD OIL products



In the pit. Hervie Dillingham and Lars Cassell, Standard Oil lubrication specialists, inspect Big Paul hydraulic jack.

When Peabody Coal Company management launched River King mine, one of the world's largest coal mining ventures, they called for: (1) A study of lubrication and fuel requirements for the entire operation. (2) Top-quality products that could lubricate and power the equipment without failure under all conditions encountered in coal mining. This was to be done with a minimum number of products to make sure there would be no unnecessary inventories and to minimize the chances of misapplication. (3) Qualified fuel and lubrication technical service. They found what they were looking for at Standard Oil.



Standard's Hervie Dillingham, lubrication specialist with more than 20 years' experience providing technical service to coal mines, made the lubrication study. The Standard Oil products he recommended have been used extensively in coal mining operations. Hervie has recommended them before and from experience knows their ability to perform.

In the processing plant. Herb Fox, plant superintendent, inspects coal dewaterizer. This, as well as all equipment in the processing plant was started on Standard Oil products.

At the dock. Coal is moved by River King mine's railroad to Mississippi River barge loading dock. A 225-foot, 48-inch-wide conveyor moves coal from 70-ton hopper to river, loads 1,200-ton barge in about 45 minutes.

Hervie Dillingham lives at West Frankfort, less than 90 miles from the River King mine. He follows through on his recommendations with regular calls and inspections at the mine to make sure the Standard Oil products are meeting performance requirements.

Supplies of Standard Oil products are warehoused at Freeburg, Illinois, less than three miles from the mine. A Standard Oil man is ready to make deliveries to the mine any time of day or night.

Does this sound like the kind of service you would like to receive? You can get it by calling the Standard Oil lubrication specialist nearest you. Or write **Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.**

You expect more from **STANDARD** *and get it!*

USCOFLOW PLASTIC PIPE

New black UscoFlow Utility plastic pipe and fittings provide economical corrosion resistance—inside and out

A blend of styrene-base resins and synthetic rubber to give good impact resistance and high, effective tensile strength...

A simple installation—rapidly solvent welded...

A friction-free finish that maintains high flow-rate and resists build-up of scale or other deposits...

An economical price to solve corrosion and high installation cost problems that would ordinarily chew into your profits...

All this is the *new* UscoFlow line of black plastic pipe and fittings, specially designed for economical and efficient handling of fluids. It has already proven its long service life, free of maintenance and downtime, and is recommended for such applications as

salt-water lines **fresh-water lines***
natural-gas lines **electrical conduit**

A full selection of UscoFlow pipe and fittings—plus expert engineering assistance—is available at any of the selected "U. S." Distributors, at "U. S." Branch Offices, or by contacting us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

**Uscolite is approved by the National Sanitation Foundation for use with potable water.*

Mechanical Goods Division

United States Rubber

See things you never saw before. Visit U. S. Rubber's new Exhibit Hall, Rockefeller Center, N. Y.

All Mining Men Invited!

Don't Miss the

AMERICAN MINING CONGRESS

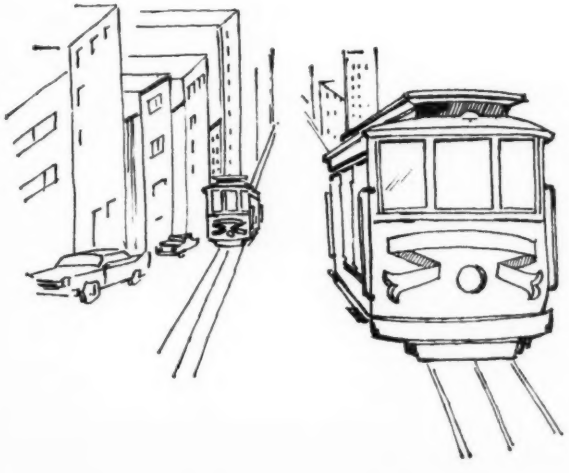
MINING SHOW

METAL MINING—INDUSTRIAL MINERALS

SEPTEMBER 22-25

CIVIC CENTER EXHIBITION HALL
AND CIVIC AUDITORIUM

SAN FRANCISCO



Come to San Francisco for the 1958 Mining Show of the American Mining Congress, September 22-25. You'll be glad you did!

See all the latest machinery, equipment and other essentials for metal mining and industrial minerals production—completely filling the Civic Auditorium, the new Civic Center Exhibit Hall, and a large outside area for equipment too large to be shown inside. The exhibits of more than 170 manufacturers will be there for your first-hand inspection and study—an exceptional opportunity to talk with the exhibitors' representatives about the operating characteristics of their equipment and its application to your own problems.

Hear leading mining men, prominent members of Congress, and top-level government officials discuss today's important mining problems—from national minerals policies . . . labor relations . . . taxation . . . strategic minerals . . . gold and silver . . . special problems of industrial minerals . . . uranium policies and developments, etc. . . . to the practical problems of underground and open-pit mining and quarrying, safety and health, and minerals beneficiation.

No registration fee, except for representatives of non-exhibiting manufacturers and suppliers. If you are an authorized dealer or distributor for one or more exhibitors, you can arrange with them for your free registration.

Don't miss the opportunity the 1958 Mining Show offers you!

Hotel reservations may be made through the AMC Housing Bureau, c/o San Francisco Convention and Visitors Bureau, Room 300, 61 Grove St., San Francisco 2, California. A deposit of $10 per room must accompany each application.

For further information please write

AMERICAN MINING CONGRESS

1102 RING BUILDING • WASHINGTON 6, D. C.

Will your shovel keep on working when its

CABLE'S ON THE ROCKS?

When the going is soft, *any* shovel cable may do. But the going is more often rough than easy—and not all shovel cables perform alike! They are not made alike.

Anaconda SH-D Shovel Cable, for example, is made by people who know mining problems firsthand—we're miners ourselves.

The insulation is a special high-grade butyl that withstands ozone, heat and moisture. Patented rubber cores cushion the ground wires and help prevent breaks from kinks and runovers. The neoprene jacket is extremely tough and abrasion-resistant. Every design and component has been job-tested under the most difficult conditions.

Why not call on the especially qualified Man from Anaconda to help with your cable problem? Or see your local Anaconda distributor. For new descriptive Bulletin DM-5818, "Anaconda Securityflex Portable Cables for the Mining Industry," write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York.

68329

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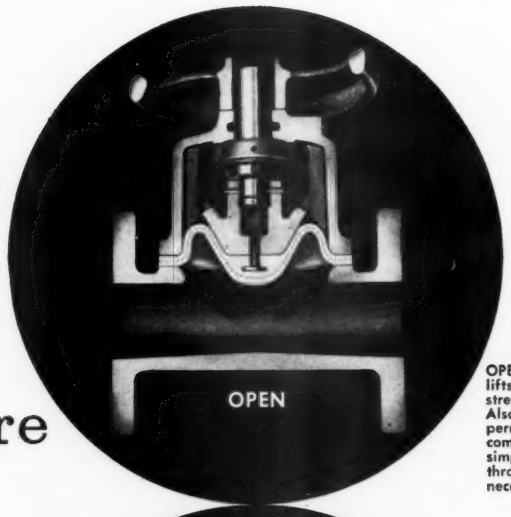
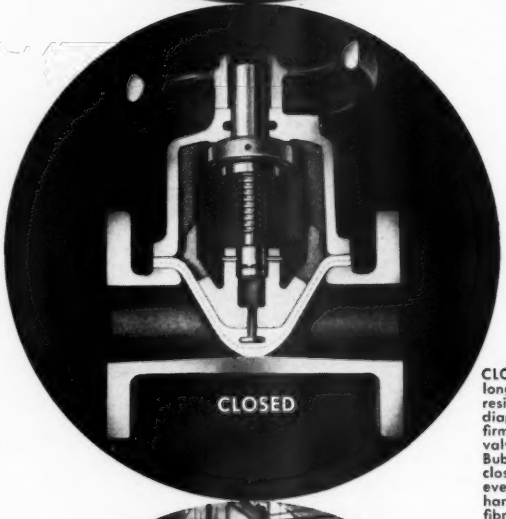


OPEN Diaphragm lifts high for streamline flow. Also, valve design permits comparatively simple rodding through, when necessary.



CLOSED Despite long usage, resilient diaphragm seals firmly against valve body. Bubble-tight closure is assured, even when handling gritty or fibrous materials.

GRINNELL-SAUNDERS STRAIGHTWAY DIAPHRAGM VALVES* are unsurpassed for handling viscous materials — semifluid foods, latex, magmas; solids in suspension — slurries, pulp stock, sludges; fluid-borne abrasives; corrosive chemicals.

The straight-through design eliminates pockets, gate trenches and other obstructions which can trap solids. The result is maximum flow, minimum turbulence, and negligible pressure drop for a diaphragm valve.

The straight-through design also has the advantage of causing very little basic change in the direction of the fluid stream, thus reducing abrasive action from high velocity particles.

These advantages are in addition, of course, to benefits normally associated with the use of diaphragm valves . . . such as freedom from corrosion and clogging of working parts, since these are completely sealed off by the diaphragm; prevention of product contamination; elimination of stem leakage and routine maintenance, because there are no packing glands. Also, when properly pitched, lines are self-draining.

Grinnell-Saunders Straightway Diaphragm Valves are available in a choice of body sizes and materials, linings and diaphragms. Handwheel or power operated. For complete information, write Grinnell Company, Inc., 277 West Exchange St., Prov. 1, R. I.

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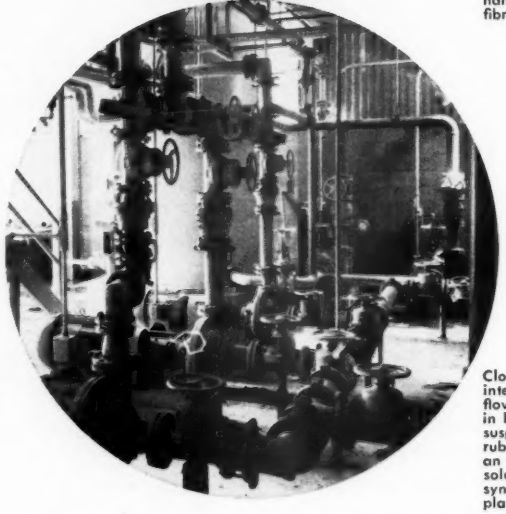

Clogging and interruption to flow is prevented in lines handling a suspension of rubber particles in an acid brine solution at this synthetic rubber plant.

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One Source for All Your Track Needs

SWITCH STANDS, such as the Model 1222, are a Bethlehem specialty. The 1222 is shown here in use with 85-lb rail. Notice how low and compact it is—overall height is only 4¼ inches! The only moving parts are lever, crank and sliding block—no maintenance worries there!

SPECIAL TRACKWORK like this can be designed, built and completely preassembled at our plant to be sure of perfect fitting at your site. The "Bethlehem approach" to your layout problem costs no more initially, and pays for itself in the long run.

SWITCH HEEL BLOCK Design 992 was developed by Bethlehem especially for use with mine turnouts. It helps maintain heel spread and track gage at heel end of switch, keeps closure rail and switch point properly aligned. Bolts can be drawn up tight without hindering the lateral movement of switch points.

A smooth, well-built haulage system is the backbone of efficient mining. Every phase and every component of your layout—from initial planning right through to rails, turnouts and switch stands—will reflect the quality which goes into them.

That's why we urge you to bring your trackwork problems to Bethlehem. We have had long experience in the manufacture of rails and accessories, and this is backed up by operating know-how acquired in our own mines. We have the facilities and engineering to help you improve your transportation efficiency.

A Bethlehem engineer is ready right now to pay you a visit and talk over your needs with you. Why not call our nearest district office and arrange a get-together?

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Now a proved DROP BOTTOM CAR SPOTTER that will give you Dependable Performance!

Here is the simple S-D "DBS" Hydraulic Car Spotter shown with Sanford-Day Power Unit.

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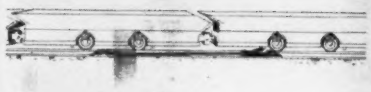
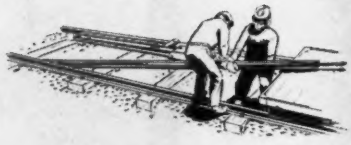
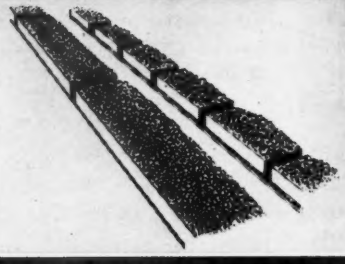
S-D "DBS" SPOTTER effectively moves trips without damaging doors because pushing dogs operate outside door compartments!



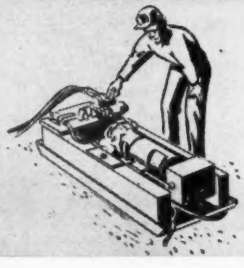
S-D "DBS" SPOTTER is the most portable spotter available. Track unit is in two sections, each 1200 lbs. and only 18 feet long.



S-D "DBS" SPOTTER offers you ONE STANDARD SPOTTER for cars from less than 10 feet in length to over 30 feet!



S-D "DBS" SPOTTER Power Unit is specially designed with hydraulic controls located on the power unit itself in one panel for convenient and easy servicing! No hydraulic control valves are located on track unit!



After several years of development and testing, Sanford-Day engineers have found the successful design in a drop bottom car SPOTTER that offers you dependable performance for far greater efficiency where fast-rate loading is desired at loading points. This new, but proved, spotter is the *S-D "DBS" Hydraulic Car Spotter.* It completes our line of S-D Spotters and S-D "Brownie" Hoists for every requirement, including S-D Hydraulic Car Spotters for Rotary Dump Cars and cars of all designs. You are going to like these S-D Spotters for their consistent effectiveness and dependability! Write us today noting your particular requirement and let us help you fit the correct SPOTTER or HOIST to your needs. Sanford-Day Iron Works, Inc., P. O. Box 1511, Knoxville, Tenn., USA.

S-D "Brownie" Hoist-and-Retriever Combination

Where loading conditions do not require a hydraulic car spotter, the S-D "Brownie" HKD Hoist-and-Retriever Combination is the efficient method of moving cars by loading points.

LOOK–they're interconnectable!

O-B "cap screw" cable connectors

*you can connect this...**

- to any other single conductor cable
- either copper or aluminum
- from 4/0 to 1,590,000 CM
- same size or different size
- straight-thru, tap-off, or three-way
- simply by tightening two cap screws!

When you leave one of these O-B connector halves semi-permanently attached to the ends of your cable, you can make any of the above connections in a minute or two simply by tightening two cap screws. All connectors have ample strength, current-carrying capacity equal to or exceeding that of the cables themselves. Smooth, slim contours tape easily, drag over rough bottom without snagging. Ask your local O-B representative or write us today for more information.

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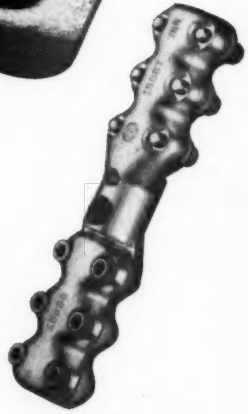
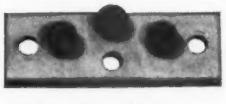


Straight-Thru Connector



Three-Way Plate

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4629-M

EDITORIALS

ROBERT W. VAN EVERA, Editor

JULY, 1958

WARTIME MONSTROSITY FINALLY BITES THE DUST

Early in World War II, the transportation facilities of the Nation were strained to the utmost by our mobilization needs. To discourage unnecessary use of these facilities, and to help raise the revenue necessary for the war effort, Congress levied a tax of three percent on payments for the transportation of freight and four cents per ton on the transportation of coal, and increased the tax on transportation of oil by pipeline to 4½ percent.

The tax on transportation was recognized from the outset as a bad example of revenue raising. It created serious inequities against producers of bulk products, and bore heavily upon the mining industry. It discriminated against the coal industry in its competition with natural gas and with imported residual oil consumed on the Eastern Seaboard. It tended to disrupt traditional freight rate relationships which to a large extent determine market areas for bulk product producers. Additionally, the tax on freight was cumulative and cost the economy substantially more than the amount of revenue realized by the Federal Government.

Nevertheless, during all the years since World War II, this war baby has stayed in the law in spite of determined efforts by mining and other industries to get rid of it. This year the outlook for repeal appeared particularly poor, because the Administration and Congressional leaders officially opposed any tax reduction and the freight tax netted the treasury some $450 million per year.

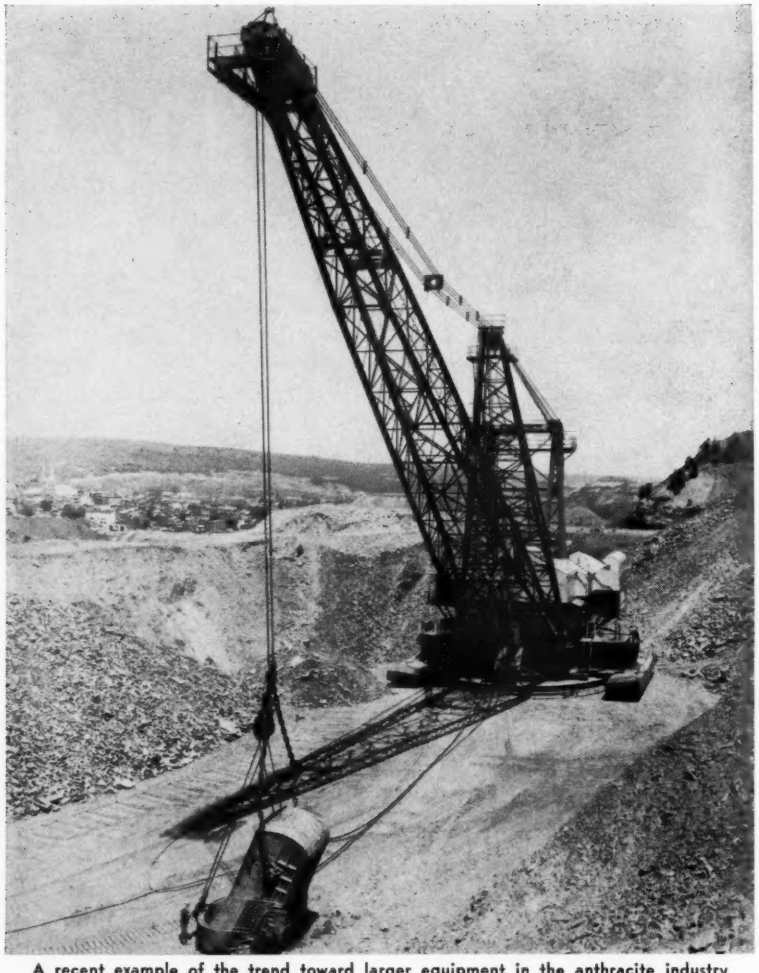
On June 30 the President signed H. R. 12695, which extends present corporate and excise tax rates, but which at long last repeals the three percent freight tax, the four-cent a ton coal tax, and the 4½ percent oil-by-pipeline tax. Occasionally we feel we are fighting the inevitable in our efforts to eliminate inequitable burdens on our economy, but this example shows that it doesn't pay to give up just because the path is arduous.

PROGRESS AND A-C POWER

In an industry where technical revolutions are no novelty, the current interest of underground coal miners in a-c mining comes as no surprise. With more and more electrical energy being concentrated at the mining face and in a single machine, the characteristics of a-c power become increasingly advantageous.

It is no small matter, however, to educate an industry which, by and large, has been committed to d-c power ever since electrical equipment was introduced underground. The committee on Underground Power of the American Mining Congress' Coal Division is aware of this problem and has instituted a series of studies to focus attention on the differences between a-c and d-c mining. On page 53 appears the first of a series of reports resulting from these studies.

A special vote of thanks is due the Committee on Underground Power for the way in which it has reacted to the need for practical information on the various aspects of a-c mining. It is through the activities of groups such as this and the other AMC Committees that the industry is kept abreast of rapidly changing fields of mining technology. Because it does keep abreast, the American coal industry continues to lead the world in efficiency of production.



A recent example of the trend toward larger equipment in the anthracite industry is the installation by the Gilberton Coal Co. of this 1250-B dragline near Shenandoah, Pa. It carries a 32-cu yd bucket on a 200-ft boom and has a rated capacity of 7000 cu yd of overburden per seven-hour shift. Note the man standing in front of the bucket

Current Practices in Anthracite Stripping

By A. E. CODDINGTON
Vice President
Carey, Baxter & Kennedy, Inc.

Two long-time anthracite strippers discuss factors that have helped to cut mining costs. Mr. Coddington concentrates on such recent developments as the use of ammonium nitrate for primary blasting, improvements in rotary and impact drilling, larger and more powerful bulldozers and rippers, front-end loaders for handling stripped coal and the trend towards larger equipment. Mr. Bazley expands the subject to include such topics as large breakers at central locations, processing refuse banks, electric welding advances, two-way radio communication and improvements in maintenance practices

FOR a number of years the anthracite industry has been annually obtaining a larger percentage of its production from strippings, or open-pit mines.

According to the records of the Department of Mines and Mineral Industries of the Commonwealth of Pennsylvania, in 1936 only 7 percent of the total fresh-mined anthracite production came from strippings. This percentage has increased to the point where preliminary figures show that about 38 percent of the total production in 1957 came from open pits.

Following is a tabulation showing the increases by five-year intervals:

Year	Stripping Production			% of Total Fresh-Mined
1936	3,757,678	Market	Tons	7%
1941	7,855,945	"	"	16%
1946	12,912,992	"	"	24%
1951	11,376,379	"	"	30%
1956	8,527,613	"	"	36%
1957 Est'd.	7,831,511	"	"	38%

These figures cover the entire anthracite region of northeastern Pennsylvania. In the southern field of the region, in the general vicinity of Pottsville, the trend toward stripping coal has been even more pronounced. The largest producer in this field, the Reading Anthracite Co., obtained about 90 percent of its fresh-mined production from strippings and open pits last year. Two of the largest projects in the region are operated by Reading at Shenandoah and Wadesville. Combined production of the two operations has averaged about 750,000 market tons of anthracite annually for the past 11 years, totalling over 8,200,000 tons since their inception, with about an equal amount still to be recovered from them.

The main reason for this trend toward open-pit mining is easy to find in lower unit costs of production. For example, in 1956 the average production throughout the region was approximately 3.90 market tons per man-day; strippings and open pits produced about 7.48 tons per manday, while underground mines averaged about 2.48, a ratio of about three to one.

It thus becomes apparent that during the past 25 years strip mines have developed into a dominant factor in the anthracite industry, and all indications are that they will continue to play a major role in helping the industry to maintain or improve its position.

It is the purpose of this article to discuss current practices in the stripping of anthracite, and new developments that are helping to reduce costs and increase unit production, notably:

(1) Use of ammonium nitrate prills or granules for primary blasting.
(2) Current blast hole drilling equipment and techniques.
(3) Effect of larger and more powerful bulldozers and rippers upon stripping practices.
(4) Use of front-end loaders for handling run-of-stripping coal.
(5) The continuing trend toward larger equipment as a means of reducing costs.

Ammonium Nitrate Blasting—Cost and Performance

Undoubtedly the most important development of recent years in the technique of open-pit blasting has been the introduction of ammonium nitrate prills, or granules, to replace the conventional types of explosives. In the short space of about a year and a half their use has developed from a negligible amount to about 80 percent of the total explosives being used for primary blasting.

Two factors are responsible for this dramatic change: cost and performance. As for comparative costs, where prills are used on a pound for pound basis, a saving probably averaging about 50 percent is effected over the use of the conventional explosives. Total savings are partially offset in the anthracite region by the fact that for years the price of the latter has included service—i.e. delivery of the material to the site of the blast, assistance in loading and connecting up the holes, and technical advice on hole spacings and special problems. These, of course, are not available at the bulk prices of ammonium nitrate and must be provided by the user at his own expense.

Tractor-drawn carryalls strip surface and shale overburden at a stripping operation of the Reading Anthracite Co., near Mahanoy City, Pa., while a nine-yd dragline strips overburden and casts coal for loading with small coal shovel

As for performance, stripping men throughout the anthracite region, almost without exception, agree that on a pound for pound basis, results being obtained with the use of prills are equal to, or better, than those formerly obtained with the conventional explosives. The experience of Carey, Baxter & Kennedy, Inc., shows that in one of its most difficult pits, near Wilkes-Barre for the Hudson Coal Co., where the rock overburden is badly caved and distorted due to previous underground mining, the firm has had less secondary blasting since introducing prills than previously. At other operations this stripping contractor has had uniformly good results in the face of widely varying conditions.

The technique of using prills varies somewhat throughout the region, but is basically the same as in other sections of the country. Various types of primers are used, but most are the ammonia dynamites (Amacol, Hercol, Hi-cap, etc.) in 25-lb sticks. For down-the-hole initiation, a 2 by 12 in. stick of 40 percent gelatin is usually added to the primer. Total detonator averages about 7 percent of the prill charge by weight, but some operators are experimenting with as little as 2 percent with no misfires reported.

Initiation may be down the hole or at the top, with a cap in every hole or with a Primacord net-work. Millisecond delays are used where vibration is a factor. In any case, each hole has a column of plain or plastic Primacord. Fuel oil additives average about 10 percent by weight, or 1.4 gal per 100 lb of prills. Some operators meter the fuel oil into each hole from a service truck, while others approximate it with a sprinkling can or bucket.

At an operation near Shenandoah for Reading Anthracite Co., Carey, Baxter & Kennedy purchases the prills, or granules, in 50-lb bags in 40-ton carload lots, at a delivered price of about $81.00 per ton in this area. Several sources of supply are available, but a uniform freight rate makes delivered prices competitive, whatever the shipping point. The bagged prills are transferred to a frame and sheet-iron building at trackside having a storage capacity of about a carload and a half, with the bags stacked loosely about eight tiers high. Portable aluminum roller conveyors facilitate the handling of the bags. Another operator uses a forked lift hoist to handle the bags after they have been stacked loosely on light-weight pallets.

The firms blasting crew, as required, consits of two men trucking the bags to the site of the blast, a chargeman and miner placing the charges and adding the fuel oil, and, as required, a driller and drill helper tamping the holes. This crew can readily handle a 30,000-lb blast in a normal seven hour shift.

Powder companies have been most cooperative in this important and radical change in blasting practices and much credit is due them, their representatives and technical men for their helpful advice. One of the major explosives companies has recently in-

After graduation from Cornell University in 1927, A. E. Coddington was employed by Stone & Webster Engineering Corp. as design and layout engineer on anthracite coal preparation plants for four years. During the next four years, he was mining engineering assistant for West End Coal Co. and Pierce Management, Scranton, Pa. In 1935 he joined Carey, Baxter & Kennedy, Inc., stripping contractors for the Reading Anthracite Corp. near Shenandoah, Pa., and for Hudson Coal Co. near Wilkes-Barre, Pa. Since then he has engaged in many stripping projects throughout the anthracite region.

troduced a product which more nearly compares with prill and fuel oil mixtures in price, called Nitro-Carbon-Nitrate. This products has the advantage of being obtainable in various forms to meet the requirements of individual stripping jobs, and may further reduce blasting costs in this region.

Current Drilling Equipment, Techniques

With a few exceptions, the gradual transition from churn drills to rotary drills, or to combination rotary and percussion types, is now complete in the anthracite region. Where a few years ago the churn drill was standard equipment for the drilling of blast holes, there are now few of them in service. Here again, the reason for the change has been improved performance at lower operating cost of the rotary drill types.

A great deal of the primary blast hole drilling in the region involves "broken holes", drilling through overburden that has been pulled or crushed due to previous underground mining. Even under these difficult conditions, the rotary drills have been found to more than double the over-all performance of the churn drills.

For the larger blast holes, from 9 to 12¼ in., the Bucyrus Erie Models 50-R and 40-R are widely used in the region, while for the smaller diameters from 4½ to 7½ in, Joy, Ingersoll-Rand, Schramm, Reich and Keystone have found acceptance, either with track mounting or truck mounted for greater mobility from job to job.

Under widely varying conditions of rock hardness, stratification and solidity, average footages per seven hour shift are probably about 250 vertical ft of hole, with footage per tricone bit varying all the way from 50 to 8000 ft, probably averaging about 3000 ft per bit. Hole spacings vary from 14 ft by 14 ft for the smaller holes to 24 ft by 30 ft for the larger ones.

The rubber-tired overhead loader can be moved rapidly from one stockpile to another for blending purposes, with very little loss of loading time

The Correale Construction Co. of Hazleton, with large scale operations near Minersville and elsewhere, have long been advocates of the use of 12 in. diameter blast holes, and are currently operating three Model 50-R rotary drills with 12¼-in. bits. Holes are spaced from 24 ft by 24 ft to 24 ft by 30 ft, depending on the rock characteristics. Depths range from 35 ft for shovel and truck work, to 150 ft or more for 25 cu yd dragline cuts. The company presently is averaging slightly less than 200 ft of hole per seven hour shift in various types of rock, with bit life ranging from 700 to 5000 ft, again depending on the rock being drilled.

Advantages of this practice, costwise, are substantial for large, high-production equipment such as Correale has, and where the scope of the work justifies the initial investment required. Other operators and contractors in the region are also using this technique.

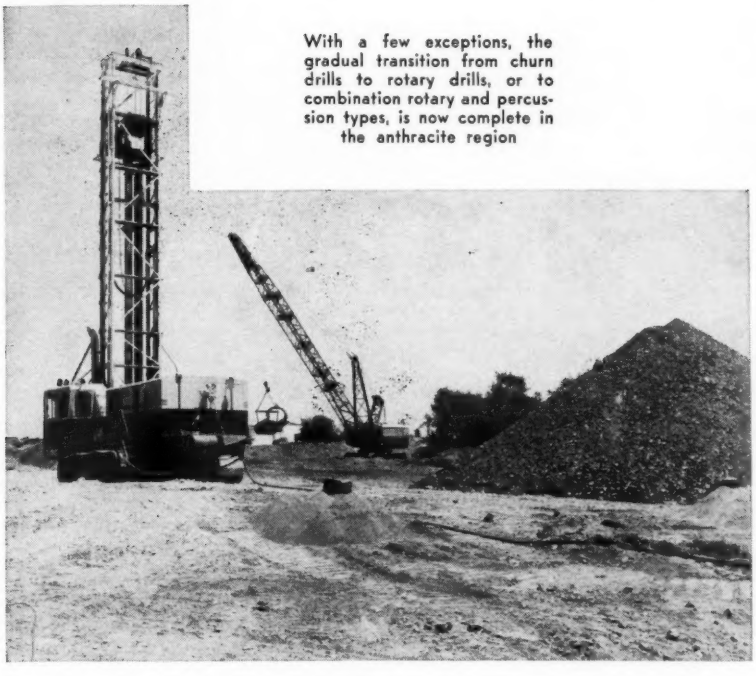
Use Larger, More Powerful Bulldozers

Practices and opinions vary widely throughout the anthracite region as to use of carryalls as primary overburden movers. Most stripping projects in the area involve relatively small percentages of "common" or surface excavation, and for this reason some contractors feel that their use is too limited to warrant the investment required. Carey, Baxter & Kennedy has been using them to good advantage for the past 18 years, but not entirely on stripping work.

The use of carryalls has recently been widened with the development by several manufacturers of heavier and more powerful bulldozers. Equipped with torque converters, they are more efficient than previous models for pushing carryalls during the loading process. With bowl blades attached, and given the proper conditions, they can move important volumes of loose material efficiently, where disposal areas are within, say 500 ft. With the new type ripper attachment, which is designed to be an integral part of the machine, they can prepare shales and light sandstones for efficient loading by carryall to depths not heretofore possible.

This development, in our opinion, has been of real importance in permitting stripping to higher ratios, since where the dump area is favor-

Two 1150-B draglines with 25-cu yd buckets work in tandem. In 1956 anthracite strippings and open pits produced about 7.48 tons per man-day, while underground mines averaged about 2.48



With a few exceptions, the gradual transition from churn drills to rotary drills, or to combination rotary and percussion types, is now complete in the anthracite region

ably situated and within, say 1500 ft of the pit, unit cost of carryall excavation is below that of shovel and truck haulage. This type of equipment may be particularly useful and efficient where the cover over a stripping project consists of some breaker refuse or culm, as is quite frequently the case in this area.

Use of Front-End Loaders

With larger and larger draglines having been put in service in the region, undertaking successively deeper stripping pits, it has become an accepted practice throughout the area to "cast the coal"—i. e. to lift the coal uncovered by each cut of overburden out of the pit with the overburden dragline and stack it on the surface level for later loading into trucks, instead of leaving the uncovered coal in the pit for direct loading.

While this practice involves double handling of the coal and loss of overburden time for the big dragline, it has three important advantages: (1) Elimination of the need for a ramp into, and haulage road in, the pit; (2) immediate availability of a portion of the exhausted pit area for dump room for the succeeding cut, and (3) the leaving of a partially backfilled area instead of an open cut as the pit is advanced. These advantages often outweight the disadvantages, especially where a long upgrade ramp would be required to haul the coal from the pit.

Where dragline pits are operated in this way, the loading out of the stacked coal for haulage to the preparation plant is normally done with a coal-loading shovel, usually of one or two yd capacity. Recently, however, several operators in the region have been using rubber-tired front-end loaders for this purpose, notably the Sullivan Trail Coal Co. of West Pittston, and the Gilberton Coal Co. of Gilberton. Several manufacturers have developed these loaders into very sturdy units, with bucket sizes all the way up to six yd.

Advantages of this type of loader over the conventional shovel are greater mobility and lower operating cost. The rubber-tired unit can be moved rapidly from one stock pile to another for blending purposes, with very little loss of loading time. Servicing, greasing and repairing can be done in the shop with regular repair forces, eliminating the need for a service truck and weekly repair shifts. The unit is operated by one man, and no "spotter" is needed because the loader goes to the truck instead of vice versa. No part-time bulldozer is required for clean-up at the stock pile because the loader does its own cleaning up.

A disadvantage of the front-end loader for this service is its inability to sort out oversized rock, or perhaps timber and mine rail that a large dragline may unavoidably cast out with the coal from a mined area. Where run-of-stripping coal is being paid for on a delivered ton basis, it is essential that these extraneous materials be removed. Use of the loader involves such substantial savings, however, that their use will bear close investigation.

Trend Toward Larger Equipment

The anthracite industry has always been receptive to the use of large equipment as a means of reducing costs. Ever since our company introduced the first large walking draglines into the region near Scranton in 1931, the trend has been toward bigger units, until today practically every manufacturer of earth moving equipment and related tools has found a market here for his largest and most efficient models. An exception to this is the large high-lift stripping shovel, for which there are few applications in anthracite due to the geology of the region.

The most recent example of this continuing trend is the installation by the Gilberton Coal Co. of a Bucyrus Erie 1250-B dragline. This huge machine carries a 32-yd bucket on a 200-ft boom, and has a rated capacity of 7000 cu yd of overburden per seven hour shift. Under average conditions it will uncover over 3000 tons of marketable coal per 21 hour day.

The investment of nearly $2,000,000 in this equipment by Gilberton Coal is an indication of their confidence in the future of the industry, and an example of the forward-looking management that has been characteristic of the region for years.

These current practices are all factors in helping to achieve the lower costs that are necessary if anthracite is to maintain a favorable price differential in the highly competitive space heating field, and to expand its potential markets in the industrial field. Stripping projects that a few years ago were not considered feasible are being re-examined in the light of these new practices and methods. No longer is there a "rule-of-thumb" ratio to which stripping can be done at a profit. Each project is being studied carefully on its own merits.

Much of the success of strip mining in the anthracite region must be attributed to the willingness of operators and contractors to adopt new and more efficient equipment and practices, and to the manufacturers and suppliers who constantly strive to improve their products. They may be sure that still more efficient machines and tools will be given an open-minded trial in the region.

What the future holds for anthracite is difficult to foresee, but operators are realistically optimistic that industrial uses of the product will gradually increase to help off-set losses to competitive fuels in space heating. Meanwhile, stripping and open-pit mining men will be found doing their utmost to hold down costs while increasing unit production.

Discussion:

By JAMES R. BAZLEY

Vice President
J. Robert Bazley, Inc.

THE four newest developments in anthracite stripping have been amply covered by A. E. Coddington. The purpose of this article will be to briefly discuss four or five lesser topics which, when added to the overall picture, all contribute to one conclusion—that of lowering the price of a ton of raw anthracite coal.

Coal Precleaned at Source

As a matter of economy, coal producers are now building and operating large breakers at central locations to prepare the raw coal for market. For example, Reading Anthracite Co. today prepares all of its coal at the firm's St. Nicholas Central Breaker. As recently as 1955 Reading operated three separate breakers and many years ago, a breaker at every major mine opening.

To avoid the increased cost of transporting raw coal containing a large amount of vein refuse and extraneous material to the central breaker, the coal produced at the stripping pits or mine openings is now being precleaned at the source. These precleaning plants range in size from portable grizzlies to plants having shakers and picking tables where all plus six-in. material is scalped off and hand-picked and large lump coal crushed to minus six-in. size.

More elaborate cleaning plants employ high gravity cleaning processes which permit the reclamation of coal from refuse banks, etc. To transport this material, as is, to the final cleaning plant would elevate the cost beyond the economic limit.

Reclaiming Refuse Banks Becomes Profitable Undertaking

The result of processing refuse banks is twofold: First, it increases the production of steam sizes of coal and, second, it makes available for stripping coal land previously unavailable because of the economics involved in removing the refuse banks.

Although the steam sizes — buckwheat and under—are the real saleable products today, only a few years ago these sizes, having little market value, were deposited on the refuse banks. Power plants, commercial buildings, and the modern home stoker have now created a demand for these sizes. As a matter of fact, it has even become common practice for the producers to crush into steam sizes the harder to sell sizes such as broken, egg, and, at times, stove coal.

The second result—that of making stripping land available—is even more important in many instances. Years ago when mining was first begun, no one realized the tremendous advances that would be made in stripping equipment and techniques. Consequently, mine and breaker refuse was deposited at the most convenient site, which many times meant that coal veins were covered. Now it becomes important to move these refuse banks to make the coal available for stripping.

Electric Welding Advances

On an entirely different line of thought, let us examine electric welding advances in recent years. Before World War II there were only a few different types of electrodes to weld the various steels, namely the conventional all purpose and the high tensile coated types of electrodes. With the advent of the low alloy high tensile steels, it became necessary to develop electrodes designed to meet the critical mechanical requirements of these steels. First came the development of the low hydrogen type of electrode, which still provides good welds, but which presents some problems, paramount of which is storage. In a matter of hours this type of electrode starts picking up moisture in the coating from the air, but today this only happens after their hermetically sealed metal cans are opened. However, because of this trait and the possibility of poor welds, the iron powder low hydrogen electrode came into existence. Besides the moisture resistance trait, this electrode has many other advantages. Outstanding among these is the higher deposition rate gained by reason of the use of higher welding currents in all positions, thereby depositing more pounds of weld metal per hour. Other advantages are arc stability, making out of position welding easier, and elimination of the requirement that the operator hold a definite arc length. The latter point is critical with the conventional low hydrogen electrode which shorts out if the arc is too short, and makes a porous weld if the arc is too long.

Two-Way Radio Communication

Another recent development in the practices of the anthracite stripper is that of using two-way radio communication. Several years ago it was indeed almost nonexistent in stripping operations, but with equipment manufacturers building bigger, more expensive equipment and union men receiving higher and higher wages, down time on a stripping job became more and more costly. In many of the locations where coal is found, the telephone is not available, and in most cases if it is available the person required to make the repairs could not be reached because of being in the field. Here is where the saving is realized as the right person can immediately be reached by radio and, if verbal instructions can help, they are given directly or, if other means of repair are required, parts and personnel can be dispatched from several locations at the same time. Down time for lack of parts or personnel is hence reduced materially. Unfortunately, the complete savings over a period of time are never seen in the ledger accounts for the same reason that the economics of preventive maintenance are an invisible asset.

Speaking of preventive maintenance, it might be well to mention that the modern anthracite operator is practicing this more and more. Regular inspections of hoist cables, suspension cables, safety cables and drag cables have prevented many costly accidents as well as costly down time. Trucks, bulldozers, drills, and all other productive pieces of equipment should also be regularly inspected. Our company, for example, will build-up a bucket with hard surfacing as soon as it is purchased and continue to build up throughout its life; thus the bucket gives many, many more hours of service before being condemned to the scrap pile. Other contractors build elaborate grease pits for servicing their trucks, while still others will overhaul engines after a definite number of hours. All of this in the interest of keeping more pieces of equipment operating more hours of the day, thus lowering the cost of the removal of a cubic yard of overburden and ultimately the price of a ton of coal.

Private Airplanes Facilitate Delivery of Repair Parts

Along this line it might be well to mention that many contractors today own their own airplane, primarily to facilitate the delivery of repair parts. With rail shipments slow and common carriers unreliable, the solution to greater efficiency, and its attendant lower costs through less down time, is being aided by the business airplane. Another aspect of the corporate airplane is its ability to get the execu-

(Continued on page 41)

INDUSTRIAL MINERALS

Two specialists—one adept in raw materials handling, the other in their utilization—meet on common ground when it comes to mining

The Role Of The General Contractor

By J. V. OTTER
Engineer-Special Services
Morrison-Knudsen Co., Inc.

THE full scope of the job that a general contractor assumes in a mining operation for the production of industrial minerals must have an objective that is twofold. First, he must complete a service for the owner that is satisfactory; second, he must show a profit for himself. Granted that this apparently obvious remark may be completely devoid of novelty; nevertheless, the word "contractor" gives a character to the job which prevents the element of speculation. The contractor is a hired hand.

His method of operation is geared to certain fundamentals, and has not varied in the world's 50 centuries of human experience. The general contractor in a mining operation follows three simple rules which, since they deal with the inexplicable potency of matter and with the immutable laws of nature, are themselves immutable. The rules are: (1) Dig it, (2) Carry it, (3) Dump it.

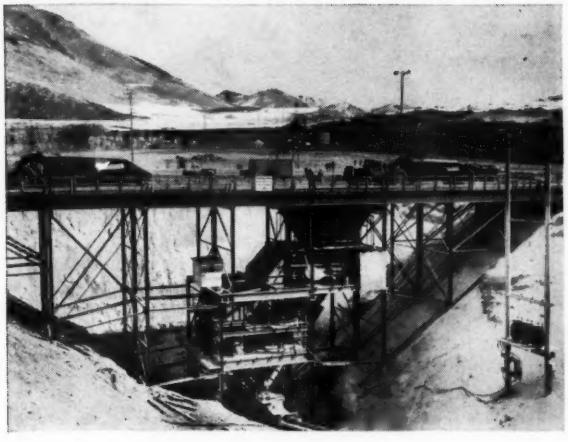
Because our subject is "industrial minerals" we must concentrate, for the most part, on the bulkier materials which come out of the earth. For purposes of this article, we shall exclude mining activities which produce either fuels or metals in our discussion of the general contractor's role. Within this narrower classification, we shall comment, by way of example only, upon a very few of those industrial minerals which Morrison-Knudsen Co., Inc., is under contract to produce at the present time, or has had experience within recent years; either directly carrying out mining functions, or indirectly in building service facilities or processing plants. A fairly complete list would include: clay, sand, gravel, broken stone, limestone, phosphate rock, sodium carbonate, quartz and uranium.

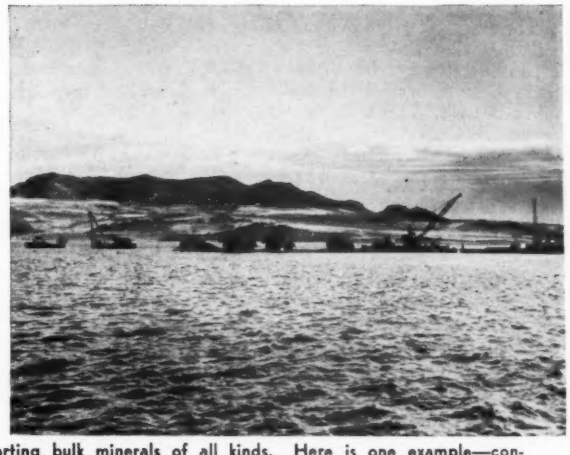
Contractors Undertake Wide Range of Jobs

General contractors are traditionally earth-movers. Historically this has been their bread and butter; likewise this has been the bread and butter of M-K since the company was organized in 1912, and undertook the construction of dams and irrigation projects for the Bureau of Reclamation in the arid west.

Since the early days of the company also, it had its hand in the construction of railroads, more specifically the embankments upon which railroads were built, involving cuts and fills. This required moving large quantities of earth, rock, sand and gravel. As the company expanded so too did these activities. Others were added. There was under-water excavation, such as required for the piers for San Francisco Bay Bridges, which were monumental works of underwater construction. Among the many war activities there was the construction of underground fuel storage in Honolulu for which the interior of a mountain was hollowed out to build a fuel reservoir within the rock of the mountain, safe from bombing. Tunnelling as a part of dam construction, tunnelling for conveyance of water for irrigation, tunnelling for railroads and highways, also form a part of the general contractors' activities.

Within recent years, M-K and its





The contractor has become a specialist in extracting and transporting bulk minerals of all kinds. Here is one example—construction of the 13-mile railroad fill across Utah's Great Salt Lake—UPPER LEFT—trucks dump rock from pit in background into crusher—UPPER RIGHT—fill material is speeded by two-mile conveyor to harbor—LOWER LEFT—bottom-dump barge is loaded —LOWER RIGHT—trucks place fill on top of subsurface material previously dumped by barges.

joint - venture general - contractor partners have built numerous appurtenant facilities for mining companies. One of these was the construction of a railroad from Puerto Ordaz in Venezuela to Cerro Bolivar where an iron mine is located some 100 miles distant. This involved not only the construction of the railroad, but an access highway of similar length, and the ore handling and dock facilities on the Orinoco River. Another was the Vitoria-Minas railroad in Brazil, also to the iron mines. In Labrador a large railroad construction job was carried to completion to reach rich iron ore deposits.

In addition to this, and through the medium of M-K's subsidiary, The H. K. Ferguson Co., pertinent facilities have been designed and constructed for mining companies which process raw materials into useful products.

Many Contracts Are Essentially Mining Operations

From a practical point of view a mine is a place where there is an abundance of some particular material. The process of mining is the occupation of transporting the material from its place of abundance to a place of particular use. Mining is juxtaposition; nothing more.

Today, the men and machines of Morrison-Knudsen are erecting an "island" 13 miles long, ranging in width from 175 to 480 ft. Its base is on the floor of Utah's Great Salt Lake.

It is strictly a dig-it-carry-it-dump-it job which makes it a mining operation. It is owned by the Southern Pacific Railroad, with M-K taking the part of a hired hand, which makes it a "contractor's role." From the first scoop of bottom fill, through the heavy rock which emerges from the lake's surface, to the final topping layer of ballast rock, it is composed entirely of industrial minerals. Accordingly. it appears to have the qualities for discussion here.

The contractor's role begins before he has been awarded the contract. He must first assist the owner by making exploration of the project, then he must be in a position where he can make field investigations, and present designs and negotiate a contract. This is a run-of-the-mill service which a contract must offer the owner in the mining field.

There is a certain fascination to the size and weight of things. The Planet Earth weighs six sextillion and 594 quintillion short tons (they say) and an atom's minuteness is beyond the comprehension of all but a very few. But how much does a 13-mile body of land weigh? Where to carry it? Where to dump it?

About here is where the contractor's experience really comes into account. This is not the place for a novice, because on his judgment will depend (for a contractor) the all-important combination of satisfaction and profit.

At this point there is a temptation for the author to copy the records and tot the aggregate of equipment used together with the amount of materials involved. This however, would reduce the discussion to a job specification, which is insufficient. The present focus must remain on the role of contractor, a function far more extensive. It is the general method of operation that is important because, although a single operation is graphic and informative, the con-

tractor may be—and probably is—involved in several more operations, no two of which are likely to be identical.

In the first phases of building the Salt Lake fill, the cumulative professionalism and imagination of job-planning personnel were put into play. When the sources of material had been pin-pointed and obtained—that is to say, the quarries which would furnish the gravel and rock for the fill—they were sure of two things: the job location, and the sources of supply. The next step was to determine quantity, time and cost. This is where the computing machines came into play. Meanwhile, existing conditions at the job site were analyzed.

The most effective method of transport for the three major items: the bottom fill, the overlay of heavy stone, and the roofing of screened-to-size ballast rock, required the heaviest concentration of planning. To carry the materials, floating equipment was organized. Some of it was standard machinery; some of it was dreamed into existence. It took nine months of preparation before the job was begun.

Six bottom dump barges were built at the lake side. Each carries a 2000 cu yd cargo—equivalent to about 50 railroad car loads—and each has hydraulically operated dumping gates which can yawn open and deposit its cargo in a fraction of a minute. On the loading end, the belt conveyors are geared to fill a barge to capacity in 20 minutes.

Seven flat-top barges were constructed in Provo, Utah, and the tugs which propel the working flotilla were built in Portland, Ore., and shipped in sections on railroad flat cars.

From the time the body of land got above water, at the starting end, the surface was leveled to a road. It was then faster and easier to use land equipment.

The job of mining minerals for the Salt Lake project was not difficult. In the hills, overlooking the harbor, a crushing plant was erected, to reduce gravel pit material to size. It was so placed that a conveyor belt could be used to carry the minerals to the barge loading dock. The two-mile long conveyor system is, literally, a moving roadway which drops 400 ft. in its journey.

Charges of explosives used to blast rock out of the quarries are topped only by the Government's atomic explosions. However, there is no fury of fire in the blast. The explosives experts are too experienced to allow the energy of their charge to be wasted on fanfare. The most that a spectator can hope to hear is an eruptive grunt before he sees the loosened rock come slithering down the quarry slope.

Before leaving the Great Salt Lake Project, it might be informative to mention one more point. The contract implied, naturally, a firm foundation on the floor of the lake. This seemingly-simple process, however, became a problem of considerable magnitude as soon as the engineers began a search for the bottom of the lake.

In the course of the 23,000 years which have elapsed since (geologists say) the lake settled into formation, the basin has acquired a sizeable sediment, often about 25-ft thick. It is mostly decayed shrimp but, to all appearances, it is a troublesome and costly slab of muck and slime, far too viscous to be used as a flooring. It had to be dredged out before the manufactured peninsula could be anchored, otherwise the completed job would not have the unyielding sturdiness required for its ultimate purpose, which is to support a railroad.

The contract to build the Great Salt Lake fill, is used here as an example of a mining operation, for the simple reason that it hardly has the appearance of a mining contract at all. And here, precisely, is a point of emphasis: *that it is quite possible to be involved in mining industrial minerals without even knowing it.*

Under the scrutiny of competent men, every phase of the project's structure fits its proper niche in the dig-it-carry-it-dump-it job of mining. Even the vacuum-cleaning operation on the lake floor is essential to the contractor's role because, without the dredging, the "dump-it" phase of the job would not have been "to the owner's satisfaction."

Relation to Mining Company Is Usually That of "Hired Hand"

Let us change, briefly, to another facet of the contractor's role. In his general lexicon, the word "prospecting" appears to be incongruous. But, it is not, because modern-day prospecting is a far cry from the traditional character who searched the remote places all alone, with nothing to hold him together but high optimism and a grub stake.

These days, it is a knowledge of geology, sensitive instruments—which are operated sometimes even from airplanes, drilling and probing which make up the prospector's working day.

The contractor steps into the picture when it is time to build an access road, clear a landing strip, drill into the earth or remove the overburden.

So far, nothing has replaced the prospector, because the earth guards her treasure under a protective crust just as surely as the succulence of an orange is guarded by its skin. The protective coating of the earth consists of the foliage, mountains, the desert and the bodies of water. It is the contractor's job, ordinarily, to get under the skin, so to speak, after the location has been pointed out to him. There is no set rule about this, however, and there may be instances in which the contractor will run the full gamut, from prospecting to the final act of processing.

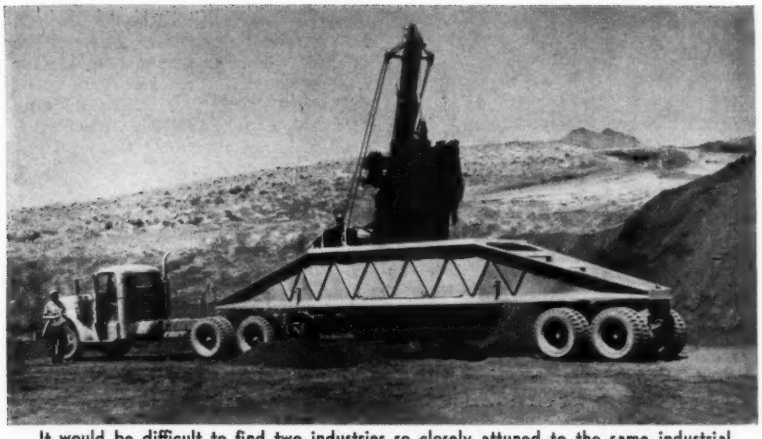
In this broad range of activities contractors sometimes engage in the extraction of minerals which will be used for the manufacturing products so broad and diverse that they will very probably lose their identity as minerals before they reach the market shelves. In this phase of the work it is very probable that the contractor himself has little concept of the minerals ultimate use.

Nevertheless, in extracting minerals which are valuable because of their inherent qualities, rather than their bulk, the word mining takes on a more familiar connotation. It also vibrates a sentimental recollection for some of the vintage members of M-K because they can remember when the company once succumbed to the gold fever. It was in the mid-1930's. The experience was brief and informative.

One of the vice presidents of the company was chief lobbyist for the venture, and offered two very persuasive arguments: the first was that because of the seasonal nature of construction, there was some splendid construction equipment lying idle which could be adapted to the placer mining of gold; the second, that there was (and is) gold in the neighboring rivers. The project went into operation and drag lines, operating from the banks of Idaho and Oregon streams, scooped dripping bucket loads, reaching for the bed rock where gold ore rests.

The system worked, but there was not enough gold to make a profit. The operation then shifted to Nevada. The story there was different, and it looked like a profitable venture. Pokes of gold dust were hefted by company officials who were satisfied—even a little excited.

John Vernon Otter has had a long career in civil engineering and heavy construction, and has also been active as a consultant to agencies of the Federal Government; including the Second Hoover Commission Task Force on Water Resource and Power, Office of the Under-Secretary U. S. Air Force, and National Resource Planning Board in the Office of the President. In his present position as special services engineer for Morrison-Knudsen Company, Inc., his assignments include that of vice president in charge of development, engineering and sales of National Industrial Products Corp., a wholly-owned subsidiary of M-K. This corporation is engaged in mining limestone for heavy chemical and metallurgical industries in the Pacific Northwest.



It would be difficult to find two industries so closely attuned to the same industrial wave length as mining and general contracting. One of M-K's special ore hauling trucks is shown taking on a load of phosphate ore at Monsanto Chemical Company's Soda Springs, Idaho, operation

Then some visitors came to the M-K offices. They were complete strangers but they wanted a share of the take because, they said, the people from whom M-K had leased the land did not have clear title, at least not to the minerals it might contain. The court ruled against M-K and Harry Morrison resorted to his rigid dictum, "You can't make money out of law suits."

That was the end of M-K's mining ventures. From that time on, they might hire out as mining contractors, but that is something entirely different. However, the rule bends a little bit. The company has a limestone quarry, and has even contracted to do a small amount of sleuthing in the uranium fields.

Regardless of small departures, the major function of the company in mining industrial minerals is the same dig-it-carry-it-dump-it routine which best characterizes the proficiency of general contractors.

Foremost Rule—Represent the Client's Interests

Yet it would be too pat to stick to the dig-it-carry-it-dump-it operations when discussing the role of a general contractor in the mining field. Actually, the contractor's duties stretch to many more phases of the business. Whatever technical proficies are involved, the general contractor's number-one rule is to be of service to his owner. He must see the problems through the eyes of the people he seeks to serve, and have a sincere desire to help them accomplish their purposes.

A dependable contractor, regardless of what chore he is hired to do, follows a set formula, whether it is mining, road building or plant construction.

His project originates in preliminary engineering and explorations, and then designs are developed to a point of estimate, based on efficiency, cost, and returns. Not solely the returns to the contractor, but to the owner.

His construction and purchasing must be scheduled accurately, the ultimate purpose being the earliest possible returns on investors' money.

A set of such rules could be as lengthy and diverse as a contractor's duties, but there is a single over-all rule which must dominate. It is this: That the contractor must act as a representative of the client and become, insofar as it is possible, an integral part of the owner's own organization.

Equipment Reduces Capital Requirement

Owners who employ contractors must necessarily hold their focus on the price of things before they sign an agreement. For them, it is pointed out that the price general contractors charge for moving a cubic yard of earth or rock is often about the same as it would have been if the same job had been bid 20 years ago.

Machinery and labor have both soared two, three hundred percent—even more—in the vortex of the nation-wide price spiral of the past two decades. Despite this, however, the voracious drag lines and the titan shovels of the contractor whose equipment is up-to-date can dig out many times as much earth or rock with the same payroll, and do it many times faster, than they could even a few years ago. Fast movement of bulk materials brings down the price of transport. This is at once an axiom and a selling point.

Another common-sense business value in making use of a contractor is that a mining company cannot help but have a fluctuating workload. Some of the things they do are one-time operations, such as exploratory work, building access roads, hauling out the overburden, and the construction of work facilities and the plant buildings and facilities themselves. If a mining company undertook such items as these, it would saddle itself with an expanding payroll, and heavy outlays for specialized tools and equipment.

From an administrative point of view, the avoidance of capital investment is a big advantage to the mining company. Fluid, available money is a comfortable asset to the businessman who is faced with a daily outlay. Few mining companies have the special, geared-to-the-job equipment needed for every phase of the work, and the use of a contractor certainly anticipates and disposes of such necessity.

Specialized Experience Pays Dividend

In these days of finely-tuned business practices, all projects, involving materials and man-hours on a large scale are keenly competitive. They require the trained hand of a professional.

This is particularly true in mining procedures. It is too obvious to say that special equipment makes it easier for the contractor to move the earth. His profession goes beyond this. He knows, for example, where to dispose of the overburden so that it need not be moved again, or will not interfere with transport. He understands capacities, and how to take advantage of slopes. He can construct a plant because he has built them before; he knows how to make a road that is neither so sturdy that it is overly-expensive, or so flimsy that it will not carry the load.

Here is where a general contractor fits in. He is professional in his line; that is to say, he is a specialist.

In the normal course of business, a general contractor in the construction of a highway, railroad or dam, excavates earth and quarries rock, thereby becoming a specialist in that type of operation, having the experience, equipment, tools and men to do such work.

An industrial minerals mining company generally is primarily interested in the processing, sale and distribution of a product after its extraction from the earth. This, on the other hand, is their area of specialization.

The general contractor, being a specialist only in the extraction portion of that entire process is, by reason of his experience, equipment and manpower, better able to do the work of extracting raw material and its delivery to the processing plant, and at a lesser cost than if the mining company handled this portion of the operation themselves.

As this applies to extraction and delivery, it applies in the same measure to every other phase of mining where a general contractor's skill can be put to use, because the contractor is a master of method.

The Role of The Chemical Company

By O. A. POWER

Manager
Mineral Development Department
Westvaco Mineral Products Division
Food Machinery & Chemical Corp.

O. A. Power has been associated with Food Machinery & Chemical Corp. for about seven years. Prior to joining FMC, Power was general manager of J. R. Simplot Fertilizer Co. in Pocatello, Ida., where his duties included phosphate mining and super-phosphate production.

OPERATIONS of Food Machinery & Chemical Corp. cover a wide range of products, with three major classes of products; industrial chemicals, power equipment, and ordnance equipment for the armed services. It is the purpose of this article to show the importance of mining to a chemical processing company as a major source of the raw materials which are treated to yield industrial chemicals. Nearly one-half of the earnings of the corporation are derived from operations of the chemical divisions. To procure raw materials and produce useful commercial chemicals requires the combined efforts of miners and chemists, and neither group could survive without the other. Furthermore, F.M.C.'s chemical processing plants require over 2,000,000 tons of coal and coke for power production and as reducing agents in processing.

A Variety of Products Are Produced

Mineral raw materials currently required by the processing plants include; phosphate rock, trona, salt, sulphur, dolomite, barite, silica, a variety of earths such as diatomite, bleaching clay, and talc, potash, borax, lime and seawater bittern.

At Pocatello, phosphate rock, silica, and carbon in the form of coke are reacted in electric furnaces to produce elemental phosphorus, which is burned to phosphorus pentoxide and then absorbed in water to make phosphoric acid. The phosphoric acid is reacted with soda ash or potash to produce a complete series of sodium and potassium phosphates. Elemental phosphorus is also used to prepare organic phosphorus compounds by reaction with chlorine and oxygen to produce phosphorus chloride and oxychloride which are in turn reacted with alcohols to form esters.

Trona, a naturally occurring sodium sesquicarbonate, is refined and calcined to several grades of refined soda ash.

Magnesia operations began with a process based entirely on solid raw materials, progressed through a stage involving reaction between seawater bittern and lime, and presently include the reaction of seawater bittern with calcined dolomite. Products are refractory-grade magnesium oxide for high grade brick, and a variety of lightly calcined magnesias including chemical, oxychloride, and absorptive grades.

Barium operations consist of thermal reduction of barites with carbon to form black ash which is reacted with soda ash to give barium carbonate and a co-product, sodium sulphide. The barium carbonate is reacted with coke in an electric arc furnace to form barium oxide, which is sold as such or converted to the hydroxide. Minor amounts of strontium hydroxide are manufactured by a similar process.

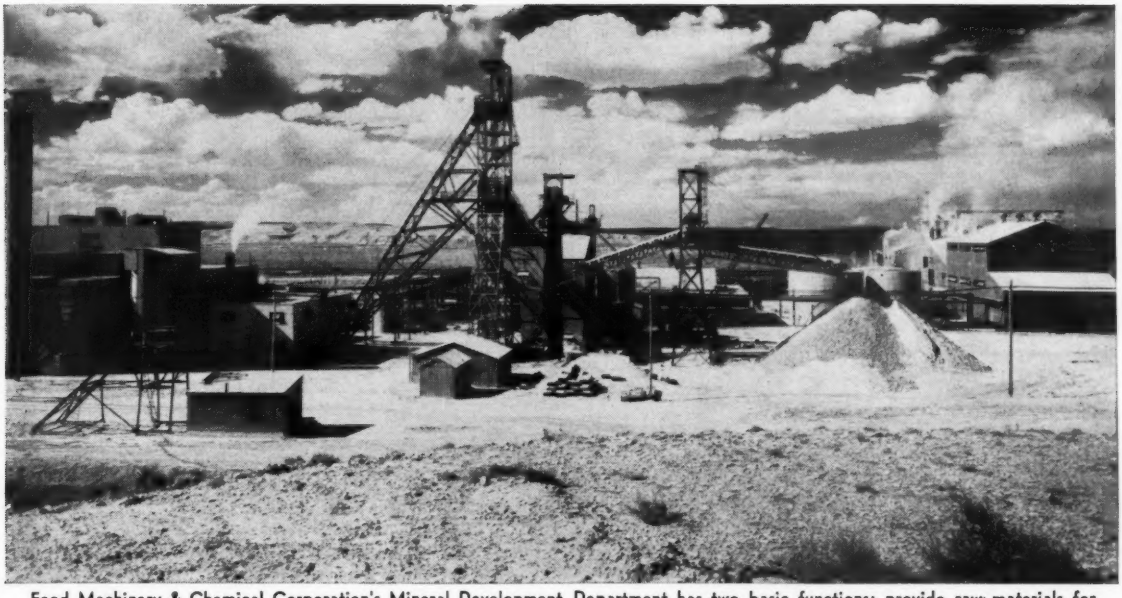
Salt is used in the electrolytic production of chlorine and sodium or potassium hydroxides in conventional electrolytic cells after careful brine purication. Final products are liquefied chlorine and concentrated commercial alkalis.

Sulphur and methane undergo catalytic conversion to carbon bisulphide and hydrogen sulphide. The sulphur is recovered from the hydrogen sulphide and recycled in the process. Another major use of sulphur is in the production of insecticides, fungicides, and processed sulphur for industrial use.

Diatomite, talc, bentonite, and clays find use as insecticide carriers, filter aids, and bleaching agents, and lime is used as a neutralizing agent in several process operations and for the removal of iron from caustic soda.

These statements concerning mineral raw materials cover only major

Mining properties are assigned to the appropriate division of the corporation, with the Mineral Development Department acting in a planning and advisory capacity or in a supervisory capacity where mining is performed by contract. Shown is Westvaco Mineral Products Division's silica mine east of Pocatello, Idaho



Food Machinery & Chemical Corporation's Mineral Development Department has two basic functions: provide raw materials for existing operations, and search for minerals that can yield new commercial products. One minerals consumer is shown—Intermountain Chemical Company's soda-ash refining plant at Green River, Wyo.

products, but they are intended to point out the variety of products derived from a few industrial minerals and the usage of products in processing other raw materials.

Exploration, Mining and Research Insure Company's Future

The corporation mines or holds reserves to protect its marketing and manufacturing positions. Materials are purchased when economics are favorable as compared to F.M.C.'s mining and transportation costs, or when the particular mineral is produced in large amounts and at stable prices, by several producers.

The Mineral Development Department, located at Pocatello, Idaho, has two basic functions. One is to explore, develop and mine raw materials for existing operations. This particular phase of the operation includes such operations as Idaho phosphate, Nevada barite and California dolomite.

The second function is to explore for raw materials other than those now used which may be chemically processed to yield commercial products.

The exploration phase of departmental activities involves physically checking a large number of mineral occurrences as the first step, followed with detailed exploration by drilling, trenching, or other appropriate means in those cases where the preliminary examination shows that such work is justified. Properties showing sufficient promise are acquired by lease or purchase, and are then fully explored to establish and develop the full reserve potential of the deposit and provide information upon which mining plans and treatment may be based.

Properties being mined are assigned for operation to the appropriate operating division of the corporation, with the Mineral Development Department acting in a planning and advisory capacity, or in a supervisory capacity where mining is performed by contract. An exception is the operation at Grants, New Mex., where uranium mining is now in progress as an operation conducted directly by the department. This operation is also an exception in that the product of the mine will be marketed directly, and will not enter a company processing plant.

The facilities of the Mineral Development Department have recently been enlarged by the addition of a metallurgical staff and laboratory. This is a necessary step, as beneficiation of raw materials becomes increasingly important due to gradual exhaustion of higher grade deposits and the increasing need for close control of grade and impurities in materials entering chemical processing. Up to the present time, mining has been conducted to produce ore suitable for plant feed as mined, but it has become evident that beneficiation of some materials will have to be instituted within a relatively short time. Low grade materials, which do not meet grade requirements for direct shipping, are stockpiled against the time when beneficiation becomes necessary.

With the exception of trona and uranium mining, all operations are open pit. Open-pit mining practice is based on the use of truck and shovel combinations to suit local conditions of type and quantity of material handled and length of haul required. Where blasting is required, drilling is usually performed by wagon drill. To provide selectivity, benches are kept small, usually 10 to 15 feet high.

The trona mining operation at Green River, Wyo., is completely underground, with room and pillar mining conducted in a flat seam about seven ft thick. Practice is similar to coal mining methods, with cutting and loading machines used at the faces, shuttle cars for gathering haulage, and belt conveyors for main haulage to the shaft. This mine has been described excellently in an article by R. F. Love which appeared in April 1958 issue of *Mining Congress Journal*.

The uranium mine at Grants, New Mex., is currently being developed and one shaft is completed and in operation. A second shaft is expected to be in operation by the time this article is published. It is planned to utilize trackless mining in regular portions of the ore body, and stopes and pillars as required in areas where the ore pods are discontinuous and irregular.

As time goes on methods will continue to be sought for turning the talents of mining men and chemists into a better way of life.

Pumping Coal and Refuse

By PAUL LEVIN
Project Engineer
Allen & Garcia Co.

Pumps and pipes are the very heart and lifeline of a cleaning plant

USE of pumps for the transportation of solids is well known in the coal industry. As the number and size of plants for the wet preparation of coal increase, the opportunities for employing pumps economically become more widespread and varied. Pumps are being used now not only to move coal and other solids through the plant, but also to pump plant rejects to disposal areas over fairly long distances and against high heads. Although this paper will be confined to the pumping of solids in and adjacent to the plant, it is of significance to note that the recently installed cross-country pipe lines of Consolidation Coal Co. in the East and American Gilsonite Co. in the West have stimulated interest in the economic possibilities of pumping for solids transportation.

Advantages of pumping, as compared to other methods of transporting solids, are, first, the comparatively low initial cost of pumps and pipe lines and, second, the convenience and ease of making the pumping installation. On the other hand, it must be pointed out that pumping generally consumes more power, and the maintenance cost of pumping is frequently higher than for competitive equipment.

The choice between pumping and other means of solids transportation is more often than not dictated by the physical state of the material to be moved. For example, where coal in a slurry must be transported from one point to another, there is usually not much question about whether or not to pump it. If, however, the coal at the initial location is in a dewatered state and must be delivered to another location in the same condition, then, very often, the logical device to use is a conveyor rather than a pump.

Types of Pumps Available

Generally, coal and refuse are pumped in a water-solids slurry by volute centrifugal pumps designed especially for this duty. Passages through the pumps are large, the pumps are rugged, and abrasion-resistant materials are used in their construction. A number of pumps on the market offer replaceable hard alloy liners. Since wear cannot be avoided, the pumps are designed for ease of dismantling and repair, and frequently provisions are incorporated to permit adjustment to be made externally to the critical internal clearance between the eye of the impeller and the pump casing. This enables the performance of the pump to be maintained at its original level in spite of wear.

Pump stuffing boxes are designed for continuous flushing to prevent the solids being handled from entering the packing. In the conventional pump, the suction is on the side opposite the shaft, but a number of pumps are available in which the suction is on the same side as the shaft. This latter design has the advantage that the pressure at the packing does not exceed the pressure on the pump suction, and in addition, dismantling of the pump is somewhat simplified. Its less desirable features are the fact that the slurry must make a 90° turn on entering the pump which promotes some turbulence, and the design requires increased overhang of the impeller on the shaft.

In general, the efficiencies of solids-handling pumps are lower than those of clear water pumps. Efficiencies in the range of 60 to 75 percent are considered good and frequently lower efficiencies must be accepted.

Some centrifugal pumps feature open impellers of various designs which are non-clogging when handling stringy or slabby substances, or which are especially effective in passing large solids. These pumps have much lower efficiencies than the conventional solids-handling pumps, but where their use is required, efficiency is usually a secondary matter.

Where very high heads and low flow rates are encountered, the reciprocating positive displacement pump is sometimes more economical than a large number of centrifugal pumps in series. The reciprocating pump is limited to pumping solids smaller than about ¼ in. in size.

Factors in Design of a Solids-Pumping System

SPECIFIC GRAVITY OF SOLIDS. As one might expect, the higher the specific gravity of the solids, the more difficult it is to pump them. Other things being equal, solids of higher specific gravity require higher velocities in the pipe line to prevent settling out. In the coal plant, the usual specific gravities encountered range from about 1.3 for coal to 2.65 for sand. Sometimes, in dense media plants, finely ground magnetite with a specific gravity of 5.0 is pumped.

SIZE OF MATERIALS. The size of the solids, as well as their specific gravity, determines the pipe line velocity necessary to transport them. The larger the piece, the higher the line velocity required. Also, very large pieces require a large opening through the pump and a large diameter pipe line to pass them. The combination of the high pipe line velocity and the large pipe line necessary for the transportation of coarse materials results in high flow quantities and thus in high power requirements. For these reasons it is often economical to crush coarse refuse, for example, before attempting to pump it away. Although most material pumped in coal plants is less than two in. in size, sizes up to approximately five in. are pumped.

PIPE LINE VELOCITY. The correct pipe line velocity for an installation is largely a matter of judgment, but in most coal plant work, line

velocities are much higher than the theoretical minimum required to move the solids through the pipe line. This provides a factor of safety to protect the line from choking due to unforseen increases in solids concentration, inclusion of tramp oversize, or failure to keep the pumps properly adjusted. Establishing the pipe line velocity above the theoretical minimum, however, results in higher power consumption and increased abrasive wear, but this is usually not considered an excessive price to pay for reliability and continuity of operation.

On the other hand, where very long pipe lines are being considered, a small increase in pipe line velocity results in a very large increase in power and maintenance costs. In these cases, the economics of the situation require that the pipe line velocities be fixed as close to the absolute minimum as possible. Operating close to the critical velocity requires a very careful control of solids concentration and of maximum particle size, much more than the conventional coal plant installation can warrant economically.

As an example of pipe line velocities currently used in coal plant pumping, a system was recently installed to pump 100 tph of ¾ in. by 0 refuse at 20 percent solids concentration at a line velocity of about 12 fps. This gives a pumping rate of 1900 gpm of slurry in an eight-in. pipe line. In another new coal preparation plant, pumps are handling 150 tph of 1 in. by 0 refuse with occasional oversize at a line velocity of 13 fps. The slurry rate is 3200 gpm in a ten-in. pipe line. In both these cases, the refuse is crushed from a top size of approximately five in.

Line velocities of around ten fps for pumping 1/4 in. by 0 coal through the plant are quite common. For pumping finer material, such as a thickener underflow consisting of minus 28-mesh coal with a high concentration of minus 200-mesh slimes, velocities as low as six fps have been used.

Incidentally, the carrying power of water in a pipe line is often surprising. In one operation in the East, raw coal was being pumped to a plant on top of a hill 250 ft high, at a line velocity of about 13 fps. The coal was being unloaded into the pump feed bin by a clamshell bucket from which a number of machine bolts dropped out. One of these bolts, 1¼ in. by 4 in. in size, appeared in the distributing box at the discharge end of the pipe line. This bolt had passed through the pumps, three in series, and through a 12-in. pipe line, including a vertical riser 60 ft long.

CONCENTRATION OF SOLIDS. Very often the solids concentration in a pumping system is determined by the flow sheet which will require that a certain amount of water must be pumped away with the solids. In general however, it is preferable to limit the concentration of solids in a coal plant pipe line to about 30 percent solids by weight. Actually, higher concentrations can be and are pumped, but if a system is designed for a high solids concentration initially, it is very vulnerable to inceases in tonnage above the design point, either due to periodic load swings or because the plant is loaded beyond the design capacity.

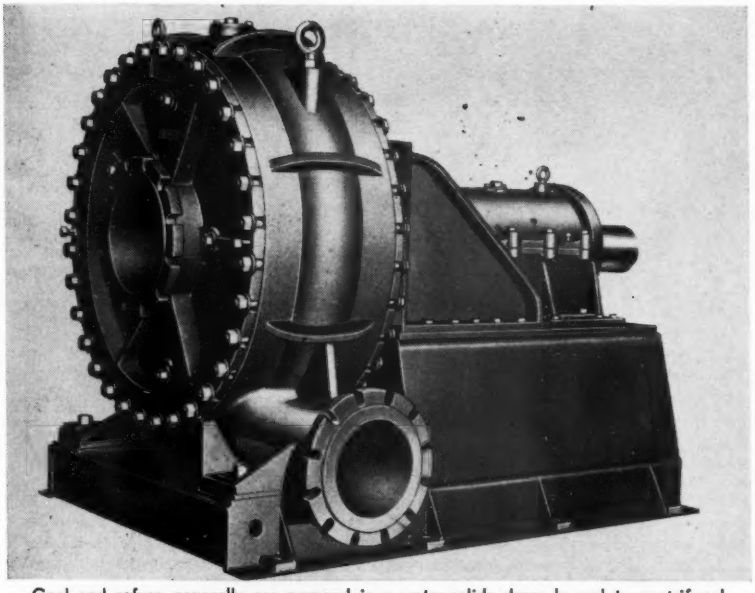
This deviation from specified design conditions often proves to be a problem to the designer. Although the tonnage to be handled by the pumps may be specified in good faith, frequently the pumps are called upon to deal with appreciable greater quantities due to an initial lack of information regarding the material to be handled or due to the understandable desire on the part of the operator to get as much as he can from his plant, regardless of nominal plant capacity. In specifying pumps and drives, the designer should keep this pitfall in mind.

PUMPING RATE. Pumps are available to handle practically any quantity of slurry which would be encountered in a coal plant. The problem usually becomes difficult, not when large quantities of slurry are to be pumped, but when small flows are involved. Although it is possible to pump solids successfully through smaller pipe lines, it is good to keep solids-handling pipe lines three in. in size or larger. This is particularly true where high solids concentrations are involved since smaller lines have a greater tendency to choke.

It might be well to point out here a phenomenon which is sometimes troublesome. A solids-handling pump will pump approximately five to ten percent more when handling clear water than when handling a slurry, other things being equal. This should be kept in mind when sizing sumps, pipe lines and make-up water supply. If a system is sized exactly right for operation with slurry, the operator may find that his tanks and sumps will overflow and that he has insufficient make-up water when clear water is being pumped, such as will occur during plant start-up and shut-down.

HEADS. In general, the solids-handling pump usually installed in the coal plant is required to develop less than 100-ft head, which is well within the limit of a single pump. A great deal of interesting work has been done lately, however, in the pumping of solids against higher heads than can be developed by a single pump stage.

Solids-handling centrifugal pumps differ from clear water pumps in that multiple stage pumping of solids is accomplished by connecting individual single-stage pumps in series. Multi-stage, single casing pumps, such as those used for the high pressure pumping of water, are not used in the coal industry for the pumping of solids. Primarily, the objection is that the wear caused by the leakage of slurry along the shaft between stages



Coal and refuse generally are pumped in a water-solids slurry by volute centrifugal pumps designed especially for this duty. Passages through the rugged pumps are large, and abrasion-resistant materials are used in their construction

is so severe as to make it impossible to keep the pump in service for any length of time. Also, the individual stages must be adjustable for wear separately, and in addition, the solids-handling pump must be easy to dismantle and reassemble. The difficulty of meeting these conditions in a multi-stage, single casing pump is obvious.

As an example of higher head operations, a recent installation required four 6-in. centrifugal pumps installed in series, each pump developing 153-ft head for a total of 612 ft. The quantity pumped was 100 tph of ¾ in. by 0 coal plant refuse in a slurry of 1900 gpm.

In another operation, in order to pump a ¾ in. by 0 Gilsonite ore from the mine to a surface plant, seven 6-in. centrifugal pumps were connected in series for a total head of 915 ft. This, incidentally, is one of the highest head installations of its kind. In this case a vertical centrifugal pump, driven by a 60-hp motor, pumped to six horizontal centrifugal pumps in series, each driven by a 75-hp motor.

Another example of high head solids pumping can be found in an eastern power plant, firing pulverized coal, which is pumping away its fly ash through six 5-in. centrifugal pumps in series, each pump developing 95-ft head, for a total head of 570 ft. Here, the pump motors were 30-hp each.

In all these cases, the pumps under discussion were located in one room at the beginning of the line rather than strung out at booster stations spaced along the line. Placing all the pumps together introduces certain problems in that the last pump stage, its packing gland and its discharge piping are subjected to the total system pressure. If, however, the system pressure is within the range of available pumps, the savings realized in locating all the pumps at the beginning of the line instead of establishing intermediate pump stations can be considerable.

From studying a number of centrifugal pumping installations it is apparent that pump wear is a function of the pressure differential through the pump and not of the total pressure on the pump. For this reason, if the pressure boosts through the pumps are equal, the last pump in a series of pumps will exhibit no more wear than the first pump.

In the examples given here, centrifugal pumps have been discussed. As an example of the application of reciprocating pumps, recently four reciprocating positive displacement pumps were installed in parallel for handling a minus ten-mesh coal plant refuse against a head of 1100 ft. In this installation each pump develops the full head required, but handles only one fourth of the total flow.

Paul Levin was associated with the river coal recovery plant of the Pennsylvania Water & Power Co. (now Pennsylvania Power & Light Co.) for many years in operating and engineering capacities. When that company built its new river bed coal recovery plant at Safe Harbor, Pa., in 1953, he was project engineer for the job. In 1955 he joined Allen & Garcia Co. in Chicago as project engineer and has been associated with many projects since then. He was project engineer for his company's portion of the hydraulic mining and transportation work of the American Gilsonite Co. in Colorado and Utah.

GLAND WATER. Solids-handling pumps require a source of clean water for the continuous flushing of the packing gland. This gland water must be at high enough pressure to produce a flow from the packing into the pump. Without the gland water flush, the solids being pumped would be forced into the packing and would cut the packing and score the shaft or shaft sleeve. Very often, when solids are being pumped at high pressure, the clean water available in the plant does not have enough pressure to be used as gland water, and in these cases an auxiliary gland water booster pump is required.

The lack of water clean enough for use as gland water is frequently a serious problem in a coal plant. Sometimes a clarification system must be installed to produce an acceptable gland water.

It is very desirable to install flowmeters in the gland water supply lines at the individual pump packings, particularly in critical high pressure multiple-stage service. This guides the operator in setting the gland water flow recommended by the manufacturer and prevents a waste of water where the clean water supply is limited.

DUPLICATION OF FACILITIES. Since solids-handling pumps are subject to unavoidable abrasive wear, they require regular removal from service for repairs and replacement of worn parts. Where continuous duty of the pumps is required, or where emergency shut-down would be very troublesome, a duplicate pump or set of pumps is often installed. Then when maintenance is required, the standby pump can be placed in service and the operating pump shut down for attention without interupting the operation of the plant.

As far as practicable, an effort should be made to install identical pumps for various services in order to reduce the number of spare parts the operator must keep on hand. Sometimes, for example, two pumps with different heads can be made identical except for their speeds or impeller diameters.

Pipe Lines for the Transportation of Solids

Pipe lines for the transportation of solids should be laid out with a minimum of changes of direction. Mitre elbows are susceptible to choking and they wear rapidly. They should be avoided. Long radius elbows are preferred to short radius ells and long radius pipe bends are best of all. Where abrasive materials such as sand are being handled, rubber pipe can be very effective in reducing maintenance costs.

It is known that when solids are transported in a pipe line, the very fine materials are maintained in suspension in the water. The coarser particles slide along the bottom of the pipe or move in a succession of leaps. This produces accelerated wear on the bottom of the pipe and for this reason, the pipe should be rotated at intervals if maximum life is to be realized.

A very common phenomenon in solids-handling systems is the falling-off of the pipe line friction as the interior of the pipe becomes polished by the abrasive action of the solids. In some cases, a "C" factor in the Williams and Hazen pipe line friction formula of 140 or even higher has been measured after a period of operation.

In installing the pipe lines, threaded connections and couplings requiring grooving of the pipe should not be used since the pipe will wear through first at the threads or at the groove where the pipe wall thickness has been reduced. Welded pipe, flanged pipe using welding flanges, or pipe connected by grooveless bolt-on couplings have all proved successful. In a long line it is well to provide flanges or bolt-on couplings at frequent intervals so that the line can be opened up and cleaned out in the event of choking. Bolt-on couplings have additional advantages in that they will absorb a certain amount of expansion and contraction in the pipe line and they simplify the rotation of the pipe line sections. Also, the use of a pair of these copulings in the pump suction line to provide a removeable section will facilitate the dismantling of the pump.

Careful alignment of the pipe to avoid unnecessary changes of direction at each length pays dividends in reducing friction loss and wear. Where gaskets are used, they should be cut large enough on the ID to prevent the gasket from projecting into the pipe and forming an obstruction. Back-up rings should not be used in welded joints.

Suction lines should be as short as possible. High points in the pump suction line should be avoided since they can pocket air and thus throttle

or cut off the flow of slurry to the pump. While on the subject of air binding, it should be mentioned that a pump installed with a horizontal bottom discharge is particularly subject to loss of prime due to air pocketing and, where possible, this type of orientation should be avoided. Preferably, the pump should be installed with a top horizontal or top 45° discharge.

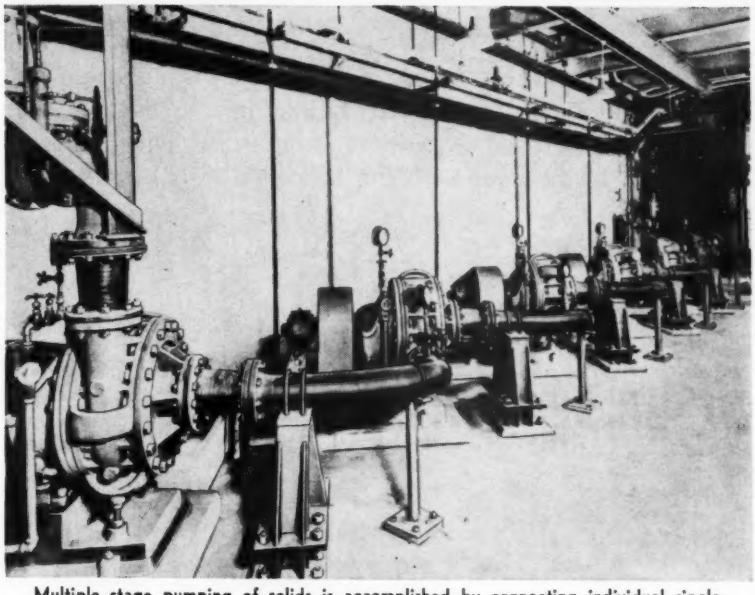
An entire article can be written on the application of valves in solids-handling installations. Without attempting to compare the various types of valves offered for this purpose, plug valves with open areas equal to the area of the pipe line have been used successfully.

Sometimes the presence of slimes and extreme fines in the slurry being pumped is considered advantageous. There is evidence that these slimes cause a reduction in abrasive wear and friction loss in the pipe line. This phenomenon may be a result of the lubricating action of the fines, or it may follow from the fact that the fines increase the density of the liquid which then maintains the coarser particles in suspension more readily and reduces drag on the bottom of the pipe line.

PIPE LINE DUMPING. In a critical solids-handling pipe line, or one which might be choked in the event of a power failure, automatic dump valves are sometimes installed to drain the pipe line whenever the pumps trip out or are shut down. It is not always feasible to do this, but where such a device can be used, it is good insurance against a choked or a frozen line.

PUMP DRIVES. From the point of view of all-around flexibility, the writer favors a solids-handling pump drive consisting of a constant speed motor driving the pump through V-belts and an adjustable pitch motor sheave. This arrangement is economical and it permits the speed of the pumps to be varied with reasonable ease. It is particularly valuable during the critical plant start-up period when the pump speed is most likely to require adjustment and when delays in making this adjustment can be costly. Also, as the impeller diameter is reduced by erosion during its operating life, the pump can be speeded up to compensate for the loss of head.

Some initial savings can be realized by using fixed pitch diameter sheaves instead of variable pitch sheaves, but in this case, changing the speed of the pump is very inconvenient since this must be accomplished by replacing sheaves. Occasionally space limitations or the desires of the customer dictate the use of direct driven pumps. While this makes a compact and efficient installation, any changes required in pump head or discharge must be effected by changing the diameter of the pump impeller, unless a variable speed motor is used.



Multiple stage pumping of solids is accomplished by connecting individual single-stage pumps in series

Another type of pump drive, not often used, is a variable speed motor. This is more expensive and less efficient than the drives previously discussed, but it provides continuous control of the pump speed without shutting down the pump, and for certain types of operation, it is very advantageous.

MAINTENANCE. The maintenance of solids-handling pumps and pipe lines can be a major source of cost in a coal plant. While such costs are part of the expense of doing business, they can be minimized by proper design and an effective maintenance program. Some of the desirable design features have already been discussed. If a pump shows excessive wear, the use of abrasion-resisting alloys in the pump or in the liners may often be the solution to the maintenance problem.

A common source of excessive wear in a pump is operating the pump at less than design head. Due to the shape of the head-capacity characteristics of the pump, the quantity pumped at reduced head can be considerably more than desired. This will cause unnecessarily high internal velocities in the pump and pipe line, thus increasing the scouring action of the solids greatly. A simple cure for this problem is slowing down the pump to bring the flow down to design rate.

When a worn area appears in a pump, local eddys trailing from the worn spot accelerate the erosion seriously and if nothing is done to arrest the wear, the pump part will cut through at the one point even though appreciable metal is left elsewhere. Operators often are able to extend the life of pump parts to a significant degree by dismantling the pumps at regular intervals and welding up worn areas to approximately the level of surrounding areas. In following this practice, care must be exercised to prevent cracking of the pump part by local overheating.

Where means are provided for adjusting the clearance between the nose of the impeller and the pump casing, the operator should follow the manufacturer's recommendations closely in maintaining this critical clearance. Neglect in this matter will result in greatly accelerated pump wear and poor performance.

BAZLEY DISCUSSION

(Continued from page 30)

tive more places in less time at costs comparable to other modes of transportation.

The door is not closed on new advances in anthracite stripping practice. Present technique for detonating shots will be improved—possibly by electronics; hauling methods will be changed by conveyors replacing the conventional truck more and more; excavators of the wheel type will be more fully developed to withstand the shock and fatigue of digging shot rock—may even be operated electronically, using television to show the operator what he is doing. Anthracite has a future, a bright future, but the price of the product must be kept within the reach of everyone by newer, bigger, more efficient, and different equipment as well as new technological advances in stripping operations.

Rockbursts are one extreme in the range from gradual to sudden failure, and they are sufficiently common in deeper ore bodies to suggest that all engineers concerned with mine planning should be familiar with the fundamentals of the problem

Planning to Avoid ROCKBURSTS

By R. G. K. MORRISON
Professor, Department of Mining Engineering
McGill University

A ROCKBURST may be defined as the rupture of a cohesive mass of strained rock in such a manner that a large portion of the accumulated strain energy is released suddenly. It represents only one extreme in the range of gradual to sudden failure.

Gradual rock failure is characteristic of all types of mining. The violent or rockburst type of failure is the exception rather than the rule. Nevertheless, with hard brittle rocks, it is sufficiently common at depth and in the more extensive orebodies to suggest that all concerned with mining layouts should be familiar with the fundamentals of the problem.

There is much that's not known about rockbursts. Certainly they cannot be entirely eliminated or predicted but, given an early opportunity, the major types can be avoided and the incidence of others can be reduced. On the other hand, if steps are not taken until serious bursting has occurred, it may be too late to exert much control in the immediate area involved.

Factors Influencing Rock Behavior

A review of the physical properties of rocks and the distribution of stress around mine openings is a prelude to any consideration of rockburst control measures.

Both plastic and elastic properties are usually present in rock deformation. For the purpose of these notes elastic deformation is that which is entirely recoverable regardless of the time factor, and plastic deformation represents all other types including rupture. At one extreme are silt stones, shales and the younger sedimentary rocks where plasticity is generally rather prominent. At the other extreme are the crystalline rocks, particularly the hard brittle types, where a high degree of elasticity is to be expected. Rockbursts are related to the elastic properties. In either case the degree of elasticity and behaviour of the rock generally will be influenced by local conditions such as the following:

1. **Shear stress**
2. **Confinement**
3. **Time**
4. **Solutions**
5. **Temperature**
6. **Physical features of the rock mass**

Stress sources in mines are related to a combination of the following factors:

1. **Gravity**
2. **Excavation of nearby material**
3. **Tectonic forces, dyke injections and crystallization, and previous variations in temperature and pressure**

The gravity stress field is related to depth and the stress build-up

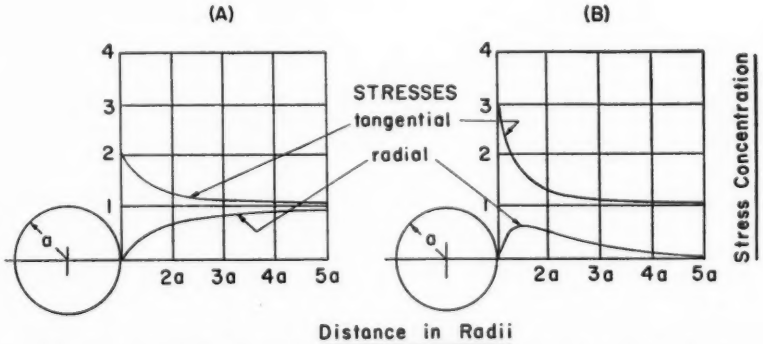


Figure 1. Areal distribution of stress along horizontal axis of symmetry for a circular hole in an infinite plate: (A) hydrostatic stress field, (B) unidirectional stress field (after USBM RI 4192)

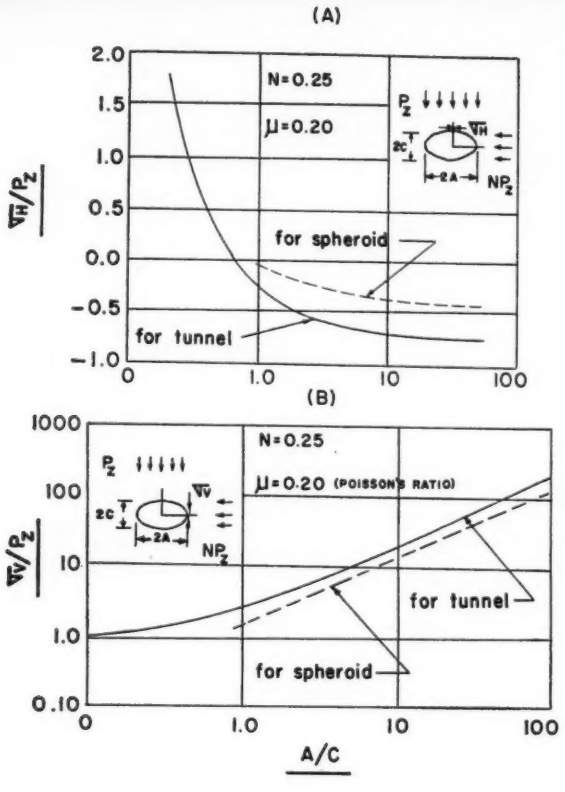


Figure 2. Ratio of circumferential-principal-stress to original-stress versus width to height ratio in homogenous stress fields: (A) at roof of cavity, (B) at mid-height of wall surface of cavity (after Terzaghi, Geotechnique, June 1952)

surrounding an excavation is related to the shape of the excavation and the original stress field before the excavation was made. The combined effect of these two sources, which can be calculated, does not seem to account for the energy liberated with major rockbursts. To explain rockbursts it thus may be necessary to invoke one or more of the remaining sources which, unfortunately cannot be clearly differentiated.

Here it should be emphasized that the type of rock is only one of several factors which may determine whether or not a mine is likely to encounter rockbursts. The original stress in the ground may be of equal importance. Some progress has been made in determining this factor, notably by the U.S. Bureau of Reclamation and by the French Department of Public Works. However, much more research is necessary before one can hope to apply such results. Thus, stress conditions in mines still can be dealt with only qualitatively.

Within this framework and the necessary simplifying assumptions it is possible to obtain patterns experimentally which will influence analysis of the problem. Based on the assumptions of isotropic elastic materials and specific stress conditions, certain results can be established by mathematical and photo-elastic studies—some of which are illustrated in Figures 1 to 5.

It is to be noted, in these sketches, that the maximum stress at the surface of different shaped openings is a function of the original stress before the opening was made. In particular, Figure 2(B) indicates that surface stresses in the order of 100 times the original stress are possible with long narrow openings such as stopes. Figure 4(A) indicates the maximum stress on pillars varies with the opening width to pillar width ratio. Figure 4(B) relates the percentage recovery in an area and the ratio of the average stress in pillars to stress before mining. Such results, which are in general agreement with practical experience, and some knowledge of rock behaviour permits the following broad conclusions:

1. **Given an opportunity, rocks are more likely to fail gradually than suddenly**
2. **An excavation at depth initiates its own stress zone, dome and fracture zone**
3. **The maximum stress intensity is related to the shape of the excavation and the principal stresses involved**
4. **The depth of sensibly abnormal stress in surrounding rocks is a function of the size of excavation**
5. **When two excavations are close to each other the intervening ground becomes a pillar representing the area of maximum stress intensity**

These are broad generalizations only which have not been improved upon in years. Experimental work progresses but there is a long way to go before the subject can be dealt with on the basis of precise calculations.

Structures Associated With Rockbursts

Pillars, remnants and planes of weakness are features most frequently associated with rockbursts. Pillars, as concentrators of stress, are perhaps the greatest single factor in rockburst activity. At shallow depth they are an integral part of mining methods. At greater depth, and in areas under undue strain, their use demands some knowledge of the risks involved. Normally the tendency to burst usually decreases with increasing hanging to footwall pillar span. It is also possible to cut pillars to a size that will induce gradual rather than sudden failure, and at the same time receive a temporary supporting value.

Shaft and barrier pillars are occasionally essential but, the safe size, in any particular case, is not open to precise calculation. In such cases there is wisdom in laying out operations in such a manner that the final size can be determined later, when there is more knowledge of ground conditions.

Stoping in such a manner that blocks of ground are gradually reduced to pillars is particularly objectionable. A common example is where several new levels are opened to flat back stoping to progress to sills below the level above. The first indications of rockbursts in many mines has been associated with such procedures.

It has been noted that pillars need not be in the plane of the lode as the ground between any two excavations can be reduced to pillar status.

Remnants of ground extending into a stoping area are subject to the same stress distribution as in pillars.

Major planes of weakness, such as faults and contacts of various types, require a somewhat abnormal stress pattern to compensate for their weakness. This may be brought about gradually by working from the weakness, as working towards the weakness may result in the sudden enlargement of the related fracture zone as illustrated in Figure 5.

Planning Mine Layouts

Shafts, Main Arteries and Service Openings

These must be located with due regard to the stress pattern likely to develop with stoping.

The location of an operating shaft is most important. A vertical shaft may be placed in the footwall, in the hanging wall, or at one end of the orebody. An inclined shaft is more often located in the footwall area. In either case some locations will in-

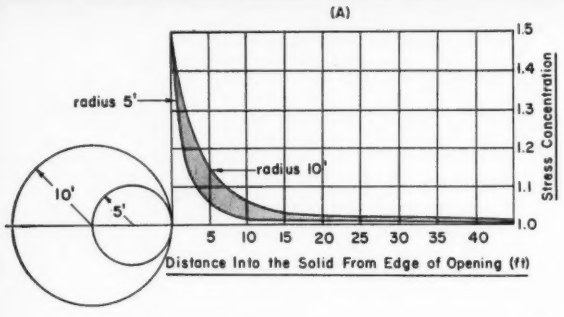
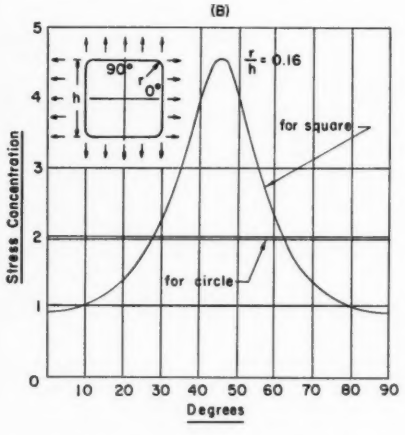


Figure 3. (A) Stress characteristics around spherical openings in an isotropic elastic medium, hydrostatic pressure (shaded area represents the extension of stress zone for the larger radius)

(B) Stress distribution around a square opening with rounded corners in a hydrostatic stress field (a stress concentration of 1.0 represents the original stress in the material before the opening was made) (after USBM RI 4192)



volve an extensive pillar to protect the shaft during stoping. The writer prefers to avoid such pillars when at all possible, and a location demanding one must be compared critically with possible alternatives.

Haulage, hoist, pump, fan and crusher installations are usually less vulnerable than shafts. Nevertheless, a stoping stress zone passing over such excavations can be the cause of rockbursts. They are thus best located to be free of such possibilities.

Stoping Sequence

Reference has been made to the objectionable nature of pillars and remnants in stoping areas and the possible effects of major directions of weakness.

Stoping should commence at a major weakness, when present, on any level and progress in such a manner that pillars and remnants are reduced to a minimum. This implies a sequence based on one of three possibilities which in effect is modified longwall mining.

1. Stoping can progress from the top downward
2. Stoping can progress from the bottom upward
3. Stoping can progress from either margin of the orebody

Considerable latitude is usually permissible in establishing any of these alternatives, but in bursting ground the sooner stoping is placed on a sequence the better. When shafts can be located so that the stoping sequence is on a retreating basis, support requirements are reduced to a minimum. The Michigan Copper Area gives many examples of successful retreating practice.

Superimposed Lodes

When two lodes are not too far apart, simultaneous stoping in each can be the cause of rockbursts in either. In practice, stoping on one lode should be kept well in advance of that on the other. With well filled stopes it may not be too important which lode is stoped first, but given a free choice, it is preferable for stoping to be well in advance in the hanging wall lode.

Branching Veins

These should be stoped in sequence from the intersection outwards, otherwise the stoping on one branch at some stage may induce rockbursts in both if they are worked simultaneously.

Support of Workings

Shafts

As mentioned earlier, in areas given to rockbursts, the first consideration is to locate the shaft in an area likely to be free from subsequent stoping strains. Given this requirement, conventional supporting practice can apply. When there are risks of ground pressure or rockbursts, circular or elliptical concrete lined shafts have advantages. In the case of elliptical shafts the long axis should be at right angles to the strike of the country.

Stopes

There was a time when it was thought that the most effective support could eliminate rockbursts. After considerable experience covering the best supporting methods, it is safe to conclude that the best stope support has no more than a modifying influence on the incidence of rockbursts. However, support of some type is necessary in all mining operations, and in rockburst country the best stope support will limit the volume of rock likely to be involved in failure. Hydraulic filling as practiced today should be particularly effective. Filling should follow closely behind the face and once placed should not be disturbed. The latter requirement becomes more difficult with increasing stope width but a stoping sequence can be an asset in this respect.

In those frequent cases where narrow open stopes are possible in ground under pressure, a suitable retreating sequence limits the requirements of support to that necessary for access to, and safe working conditions at, the working face. The most suitable unit type of support is one which will yield to pressure but at the same time maintain or increase its effectiveness. Crib sets and timber packs of one type or another have proved very effective. For this type of mining, whether horizontal or inclined, coal mining experience has many suggestions for the metal miner.

Regardless of the method of stope support, whether by fill or by unit types, safety of the working face and travelling ways must be assured. Here, in addition to conventional timber practice, the rock bolt has established itself as an effective element in the picture.

While not specifically related to support, under stopes one might also refer to the practice of blasting on the retreat and to the so-called destressing of stope faces.

If stoping operations are not on a full retreating basis it is helpful if blasting can be done on the retreat

(Continued on page 47)

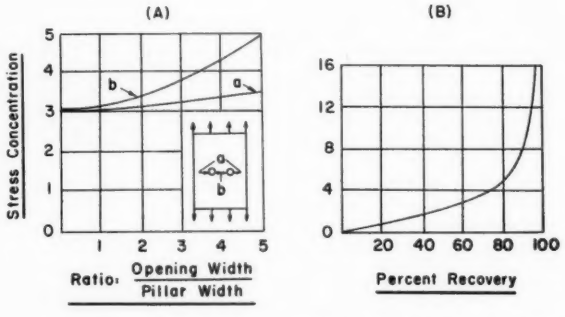


Figure 4. (A) Stress concentration as a function of opening-width to pillar-width ratio in stress field applied perpendicular to line of centers (B) Relation between percent mined area and average-stress-on-pillars to average-stress-before-mining ratio (after USBM RI 4387)

ROOF SUPPORT WITH CONTINUOUS MINING EQUIPMENT

Using crossbars and standard mine screw jacks, an Alabama mine simplifies its system of roof control to meet requirements of continuous mining

By G. C. DYAR

General Superintendent of Mines
Alabama By-Products Corp.

MAXINE mine is located on the Locust Fork of the Black Warrior River in Jefferson County, Ala. It was opened to the American seam in 1953. Connections to the surface include one 310-ft belt slope, one 300-ft material slope, and two air shafts.

The American seam averages 55 in. in thickness in this area and is generally level. It has an 8-in. rock parting, 12 in. from the seam bottom. Cover averages 250 ft in thickness. The roof and floor are firm, except in the area of thin cover where the roof is softened by the entrance of water.

Panel System of Mining

Maxine is an all-belt mine that operates three shifts per day. Three continuous mining machines and five conventional sections produce 9850 tons of raw coal per day. Eight sections are operated on the day shift, eight on the evening shift and seven on the owl shift. Sixty-six hundred tons of washed coal are loaded per day. Shipments are about equally divided between rail and water transportation.

A panel system of mining is used with 13 place ways on main and primary entries, and nine place ways on secondary entries. Five-room entries are turned on each side of a secondary entry. Room entries are three place ways, with rooms turned on both sides of the entry, and are driven 2000 ft deep. Rooms are driven to a depth of 270 ft. All headings are on 46-ft centers with crosscuts at 70-ft intervals, except in main air separation pillars where crosscuts are on 250-ft centers. Entries vary from 16 to 20 ft in width. In conventional mining 28 ft rooms are worked on 52-ft centers. In continuous mining machine work 17½-ft rooms are worked on 30-ft centers.

In mining a room entry the headings are advanced 250 ft, then the rooms on the return air side are completed. This is repeated until entry depth is reached. Rooms on the opposite side are then mined on the retreat, as the belt is recovered.

All pillars are left in place to support the overburden in order to protect another seam of coal at a 55-ft interval above the American seam.

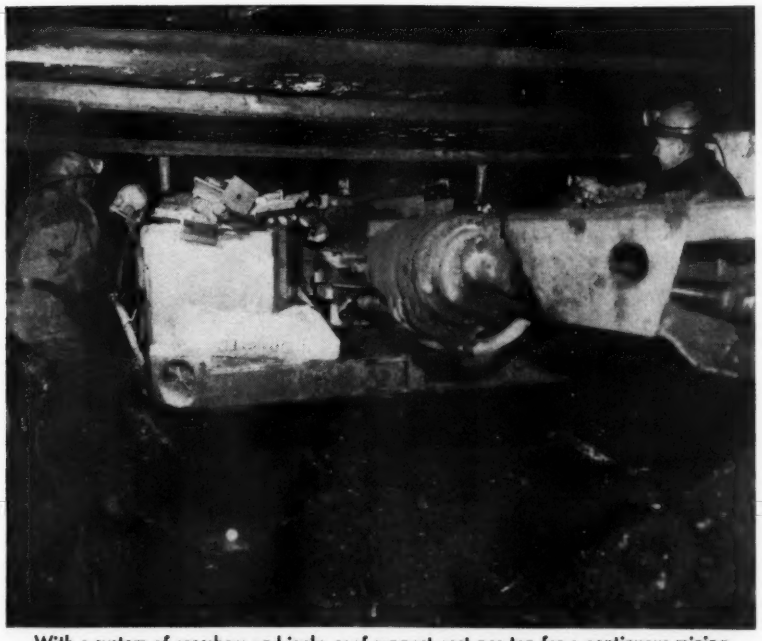
Roof Support With Conventional Equipment

The immediate roof at Maxine mine is black shale, varying from four to ten in. in thickness. This is overlaid by grey shale and shale with sandstone streaks; above this strata the first massive sandstone occurs. The roof is cut by vertical slips or planes that occur from 3 to 30 in. apart. These slips are not generally visible as the black slate immediately above the coal has healed together to form a continuous sheet about ½ in. thick.

Roof is generally good and requires small support, execpt in areas of thin cover where water has easy access through the vertical fractures. In such areas the black shale loosens, and where an excess of water is found, the grey slate above also loosens. Where conventional equipment is used this condition is aggravated by the heavy vibration caused by blasting.

In conventional mining sections the roof is supported by ⅝ by 30 in., high tensile, expansion type roof bolts. These bolts are spaced on four-ft centers in all entries and six-ft centers in rooms. Where bad top is encountered ⅝ by 40, 48 and 54-in. bolts are used, and a 2 by 8 by 24-in. oak board is added under the sole plate. The bolt spacing is narrowed and collars are bolted to the roof where extremely bad top is found.

Holes are drilled and bolts tightened



With a system of crossbars and jacks, roof support cost per ton for a continuous mining machine on a room entry section is 33 cents less than with conventional equipment in the same territory

A graduate of the University of Alabama, Grosvenor C. Dyar joined Alabama By-Products Corp. in 1953 as superintendent of Maxine mine. In August 1955 he was promoted to his present position, general superintendent of mines. Prior to becoming connected with the Alabama firm, he was operating vice president of Stith Coal Co.

by a rotary roof bolting machine operated by one man. Water is used in all drilling to allay the dust. Where roof conditions will permit, 80 percent of the bolts are recovered for re-use. A portable compressor and an impact wrench are used in recovery. It has not been found economical to recover expansion shells, so new shells are used on the recovered bolts.

Continuous Mining Sections Use Crossbars, Jacks

With the advent of the continuous mining machine some long established practices in roof control had to be reviewed. Some were discarded and others altered so that maximum production could be obtained with maximum safety and minimum cost.

Because the production from continuous mining machines is almost as high in entry driving as in room work, and as they drive a clean cut, easily maintained 17½ ft wide heading, two of the three machines at Maxine are used to advance the main and panel entries. Other factors influencing their selection for this service include the ability of two units to rapidly advance the 9 and 13-place entries without the interference and hazard experienced with conventional equipment in the same service, and the fact that conventional units are unable to operate at maximum productive capacity in the 17½-ft headings as they can in the 28-ft rooms.

In continuous mining sections, 3 in. by 8 in. by 14 ft oak crossbars supported at the ends by standard mine screw jacks are used to support the roof. These crossbars are set on four-ft centers or closer if necessary.

On a room entry the first two rooms are driven to a depth of 270 ft by first advancing one room up 70 ft to the first crosscut and mining the crosscut pillar depth to the left. Then the second room is driven up and cut into the first crosscut, a crosscut is mined to the left and the room advanced to the second crosscut and the left crosscut mined, and so on until room depth is reached.

In mining the next and succeeding rooms, the rooms cut into the already completed crosscuts, and crosscuts are mined to the left as room advances. Crossbars and jacks are recovered from the last worked out room and reused, and no effort is made to support the roof after the collars are recovered.

Warrior River loading station—shipments are about equally divided between rail and water transportation

Entries Are Roof Bolted

In entry work the first heading on the right is driven up 70 ft and a crosscut mined pillar depth to the left. The second heading is then advanced two crosscuts, holing through at the first righthand crosscut and mining two crosscuts to the left. While the continuous mining unit is in the second place, the roof is bolted on four-ft centers in the first place by a rotary roof bolting machine operated by one man. This releases the collars and jacks for re-use, and they are hauled and dragged through the crosscut for use in the face area as needed.

The continuous mining machine moves from the second to the third place and advances 250 ft, holing through at the first and second crosscuts and mining the third crosscut pillar depth, 90° to the right. This crosscut is cut at 90° as it is used for a set up hole. While the machine is in number three place, number two place is roof bolted, and the collars and jacks released for re-use.

The machine then returns to number one place and completes this place, holing through at the second crosscut and mining the third crosscut at right angles to the left. While it is in number one place, number three place is bolted, releasing the collars and jacks.

The continuous mining machine then completes number two place and holes through at number three crosscuts on left and right. This area is then bolted and the collars released.

In entries, roof bolts are set on four-ft centers after the continuous mining machine has moved to the next working place

By this system the unit is able to mine continuously, except when moving, without interference from the roof bolting machine, and the roof bolting machine does not interfere with the shuttle car haulage.

Several factors are in favor of the roof support with continuous mining machines. The units cut a place only 16 to 17½ ft in width. The ribs are cut clean and vertical and furnish support to their extreme edges. Therefore, for any given room width, actual area to be supported is less with continuous mining machine work than with conventional mining work. With the rapid advance that completes a room in 17 hours of operating time, the roof has small chance to sag. There is no roof fracture across the slip planes caused by the vibration from blasting. While a relatively larger unobstructed area is required for the machine, the immediate face area does not require support as the operator of the machine is 15 ft from the face.

The big problem is to place the supports without interrupting production. Two methods of support were considered. First, the placing of roof bolts by rotary drill rigs mounted on the continuous mining machine. Second, the use of crossbars and roof jacks. The first method was discarded after it was determined that the crossbars and jacks would control the roof safely and at a considerable saving.

Six-Man Crew

Six men make up a continuous mining machine face crew at Maxine: Continuous mining machine operator, pick up loader operator, two collar men and two shuttle car operators. The pick up loader operator loads the coal that the continuous mining unit has deposited on the floor into the shuttle cars and shovels coal from under the ventilating curtain. The shuttle car operator hauls the coal to the belt. The collar men set the collars by pushing them up across the continuous mining machine and placing them on two hydraulic jacks on the machine. These jacks raise the collar against the roof and hold it while the screw jacks are placed under the collar ends and tightened. This is done without stopping the machine. The feet of the jacks are set back in the offsets that the machine cuts in the ribs. This allows the pick up loader to work close to the rib and makes for a clean place. Accidental dislodgement by the shuttle car is minimized by this practice. These men recover the collars and jacks and haul them on a rubber-tired wagon to the crosscuts where they unload them and drag them to the face. They also shovel coal from the rib so it can be cleaned up by the pick up loader, and extend the ventilating curtain by nailing it to the crossbars as soon as the bars are set.

A sufficient number of collars and jacks are kept on hand in each section to complete one room, and on to the first crosscut of the next room. When the continuous mining machine reaches the first crosscut of the new room and cuts through, cross collars and jacks are recovered for re-use. The recovery starts at the room mouth and progresses toward the face.

Economics and Safety Considered

In this system the continuous mining machine operator is never out from under the supported area and the collar men are never more than four ft ahead of the last supporting collar toward the face. It has been our experience with continuous mining at Maxine, that large areas, where the black slate draw rock would be loosened by blasting, can be worked with this temporary support without the expense of roof bolting. With our system of crossbars and jacks, the cost has been less with continuous mining machines than with conventional equipment. In fact the roof support cost per ton for the continuous mining unit on a room entry section is 33 cents less than that of the conventional equipment in the same territory.

In addition, because the pillars are not shattered by blasting, they support the overburden in their entire width and the pillars left in place can be smaller. This allows a higher percentage of recovery where pillars must remain in place to protect a seam of coal above, as in the case at Maxine. The clean cut vertical ribs of the pillars, without the overhanging brows, do not weather and fall as in conventional mining. This saves money as clean up after initial mining is not necessary.

Continuous mining sections also lend themselves to closer supervision, and the concentration makes for an all around safer operation; all the hazards of handling and using explosives are eliminated.

The problem of roof control with continuous mining machines at Maxine resolves itself into one of keeping the working place safe just long enough to extract the coal. Sometimes the black draw rock falls shortly after the crossbars are removed from the room.

The apparent success of supporting the roof by means of jacks and crosscollars at Maxine has accomplished two things:

1. A safer method of coal mining.
2. A more economical method of roof control.

These factors add up to lower cost which is the prime requirement in the competitive coal market of these times.

PLANNING TO AVOID ROCKBURSTS

(Continued from page 44)

as the highest rockburst incidence is frequently found to be associated with blasting.

De-stressing is a term applied to springing evenly spaced long holes drilled into the stope face ahead of the normal drilling and blasting operations. The inference is that the stress intensity is thus moved further ahead of the face. It is spoken of with favor in some areas, but its usefulness is still a matter of opinion.

Levels

The unquestioned success of rock bolts has resulted in their widespread use as a level support, in many cases replacing the older conventional timber sets. New tools have to be thoroughly tried and, without detracting from the general efficiency of rockbolts, there is still doubt as to their effectiveness under rockburst conditions. Their effect must be beneficial, but whether it is entirely adequate remains to be determined under various conditions. Until this is done, a combination of steel setting and rockbolting would seem to be justified in the more sensitive areas. Any form of timber setting by itself has certainly proved inadequate in such ground.

With stoping on a retreating sequence, eliminating travelling ways through pillars and abandoned areas, the problem of level support, even in rockburst ground is greatly simplified.

As the processes at work in the walls of a mine can not be seen, they must be studied in other ways, and some variation in opinions is still possible. A high degree of co-operation between the scientist and the mining engineer holds the best hope for the future. Here one must congratulate the Colorado School of Mines on the Annual Symposium recently introduced which bears directly on this subject. Offering a forum to discuss their work and that of other agencies is a step which deserves encouragement, and is somewhat overdue on this continent.

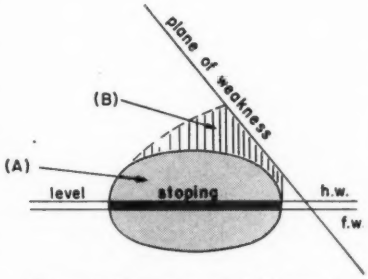


Figure 5. Fracture zones: (A) normal fracture zone due to stoping, (B) enlarged fracture zone compensating for plane of weakness

Applications of the DSM Screen

A new type stationary screen, designed for separation in the 8 to 100-mesh range, makes unique use of a wedge bar surface. Applications of the screen in heavy media circuits for draining, and its use in coal, potash and taconite plants, are described

By P. L. STAVENGER and V. R. REYNOLDS

Development Engineers
Dorr-Oliver Inc.

THE "DSM Screen", a wet screening device based on original developments by the Mining Research Establishment of Dutch State Mines, was developed to provide an economical means for more exact screening at relatively finer sizes than is normally attainable with conventional vibrating screens. In its simplest form, the DSM screen comprises a stationary screen housing with a stationary concave screen surface made up of horizontal bars. Feed slurry is introduced tangentially to the screen surface in a direction perpendicular to the bars. This unique use of a bar surface makes possible separations in the 8 to 100 mesh range at capacities per unit of screen surface many times greater than conventional screening devices. Further, in the usual form, the screening bars have a wedge-shaped cross section whereby the screen is made essentially non-blinding. Because there are no moving parts, maintenance costs are low.

Dorr-Oliver, Inc., having obtained rights from the Dutch State Mines, has been active in development and field test work with the object of expanding the application of this unique device in metallurgical and other fields. While the apparatus has heretofore been described in printed publications it is felt that the principles of operation and application are not widely known in this country. It is, therefore, the object of this article to review the principles of operation, and to indicate the applications in which the unit is being successfully utilized.

Principles of Operation

The principles of operation of the DSM screen can best be visualized by referring to Figure 1. Feed slurry enters the upper surface of the screen tangentially and flows down the surface in a direction perpendicular to the openings between the wedge bars. As the stream of slurry passes each opening a thin layer is sliced off and directed to the underside of the screen. According to Fontein (see selected references), particles roughly twice the thickness of this layer are dragged along with the undersize fraction. Particles larger than this size pass across the opening as their greatest part projects into the liquid flowing over the slot. The thickness of the layer sliced off will be primarily a function of the space between the bars. Investigation has shown that the thickness of this layer is in the order of 25 per cent of the slot width.

For these reasons it can be stated that, as a general rule, a separation is produced at a size equivalent to one half the space between the bars. For example, a 1000 micron (0.039 in.) bar spacing could be expected to produce a separation in the order of 500 microns. Tests carried out by Dutch State Mines indicate that centrifugal and gravitational forces have no important influence on the size of separation produced by the screen. For this reason the specific gravity of the particles being separated would not be expected to influence the separation.

Separation

That the size of the largest particle passing through the openings would be approximately half the width of the openings is a generalization. Test and field studies have shown that with screen openings narrower than 0.50 millimeters (0.020"), separations somewhat finer than half the slot width are produced, while with openings wider than 0.50 millimeters, separations coarser than half the slot width are produced. An approximate correlation of separation versus slot width is shown in Figure 2. This relationship is approximately true for new surfaces of the correct profile where separation is defined as the diameter of the particle which appears to the extent of 5 per cent in the undersize.

The relationship shown in Figure 2 covers the range eight to 65 mesh. Recent work indicates that the screen can be effectively used both above and below this range. Indeed, on certain materials which show only minimum wear on the screen surface, separations in the order of 200 mesh can be produced.

Efficiency

Referring again to the explanation of the principle of screen operation, it will be realized that because the separation produced occurs at approximately half of the slot width, the possibility exists of tramp or oversize particles appearing in the undersize. In this regard the basic difference between the DSM screen and the conventional vibrating screen is readily evident, for in principle at least, the vibrating screen with a fixed screen opening provides a positive stop for particles larger than the screen opening. With a vibrating screen using screen cloth or perforated plate fixed to the screen structure so as to eliminate seams or cracks through which oversize can short circuit to the undersize, almost ideal results can be expected. In practice, however, these ideal conditions are hard to meet, and are seldom realized. With the DSM screen on the other hand, the size distribution of the undersize shows consistently a minimum of oversize

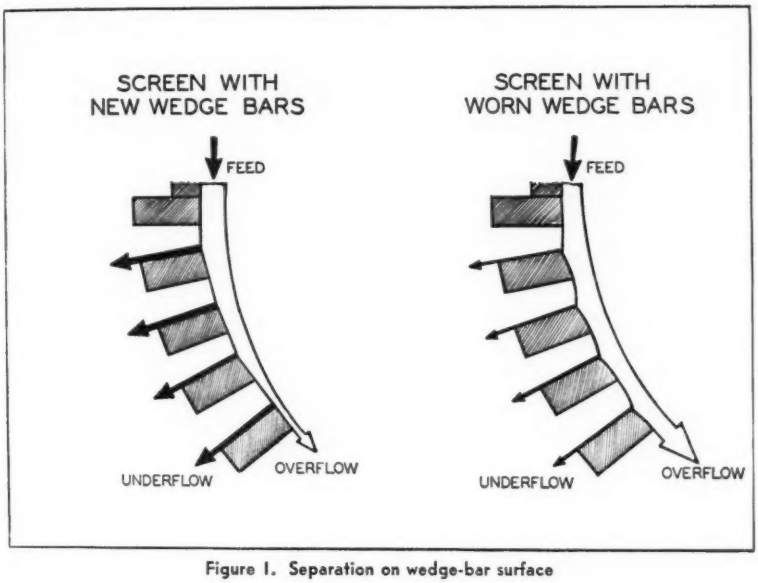


Figure 1. Separation on wedge-bar surface

material. It is similar in many respects to the overflow distribution of a liquid-solid cyclone. Comparison tests carried out in Europe indicate that the screening efficiency of a vibrating screen using wedge bars is considerably worse than the efficiency of the DSM screen. One handbook states that vibrating screen efficiencies in commercial operations are about 60 per cent, and that 75 per cent is unusually good. Commercial operations in this country with materials such as coal indicate that the DSM screen can make a 14 mesh separation at Tyler efficiencies consistently better than 80 per cent and as high as 93 per cent.

In considering the problem of efficiency it is well to emphasize that most methods for determining screen efficiency neglect one of the most important variables. This factor is the proportion of particles in the feed that are nearly the same size as the separation desired. Therefore, any comparison of Tyler efficiencies, by different methods of size separation, must take into consideration the size distribution of the feed in the range immediately finer than the separation desired.

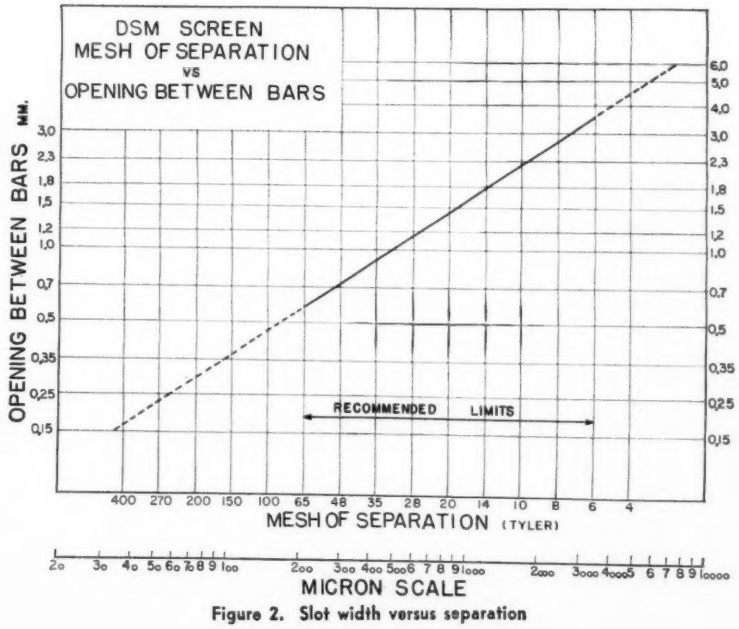


Figure 2. Slot width versus separation

Capacity

The capacity of a DSM screen is a function of the percentage of free area and velocity of the feed to the screen. The following is a relationship for determining the capacity of a DSM Screen:

$$Q = C \times F \times V$$

where Q = Capacity in gpm
F = Free (open) area of screen in sq ft
V = Velocity of feed in fps
C = Capacity factor

Using a value for C of 20 the capacity can be approximated in most cases.

The capacity per unit of screen area for a DSM screen can be much greater than that for a vibrating wedge bar screen producing about the same separation. Fontein cites two examples in which the DSM screen had capacities from 10 to 50 times the capacity per unit area of a vibrating screen.

Limitations

One of the chief limitations of the DSM screen is that the oversize product has a higher moisture content than is normally produced with a vibrating screen. For dewatering operations, therefore, it can only be considered as a primary unit. As a general rule the oversize product will not have a concentration higher than 45 to 50 percent solids by volume. This would correspond to a concentration of 73 per cent solids by weight for 2.7 sp gr solids.

Another factor to be considered is that the screen will only function properly within a relatively narrow capacity range. This stems from the fact that at capacities below about 50 per cent of rated capacity solids will build up at the discharge end of the screen.

At excessively high capacities moisture of the oversize will tend to increase, resulting in poor separation efficiency.

Effect of Wear

After a screen surface has been in service for a period of time the individual wedge bars become worn as shown in Figure 1a. This wear tends to divert most of the stream over the wedge bar, thereby causing a thinner layer to be sliced off. As a consequence the separation becomes finer. The trailing edge of the bar on the other hand tends to be worn sharper. The obvious solution to this problem is reversal of the screen surface. Such reversal of the surface may be necessary as often as once a shift in

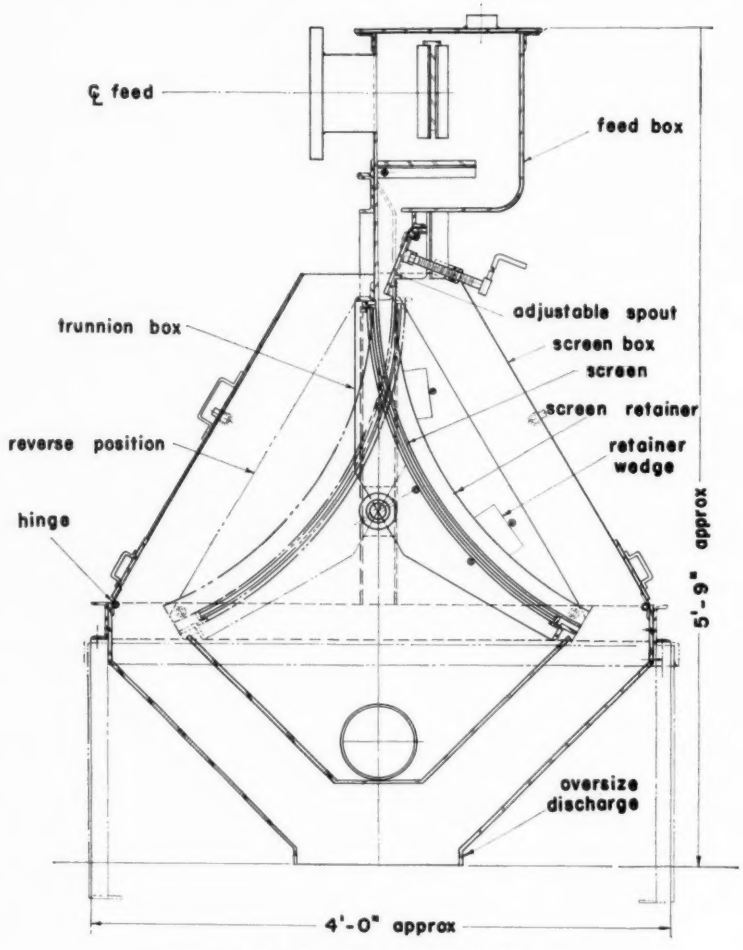


Figure 3. Essential features of Type T DSM screen

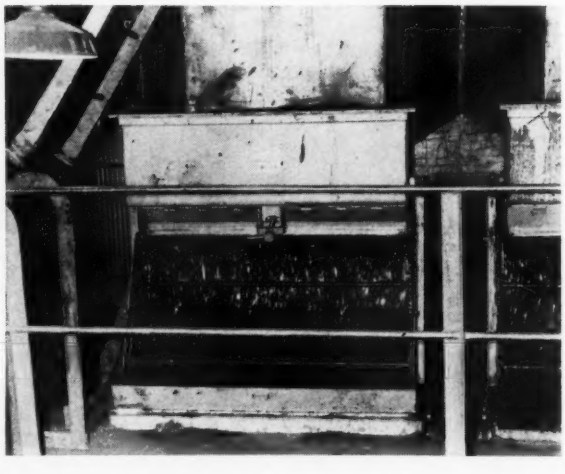


Figure 4. DSM wedge-bar screen in operation

some cases, while in others the surface can remain in one position for two or three weeks. By reversing the surface the separation can be kept relatively constant.

A wedge bar profile is used to minimize blinding and for this reason as the surface becomes worn, the space between the bars becomes greater. No great amount of data has been collected to date on the life of screen surfaces in various applications. Indications are, however, that the life will be between 600 and 2000 hr, depending on the slurry being handled.

Type "T" Screen

Figure 3 shows the essential design features of the Dorr-Oliver Type T DSM screen. The essential or most important feature of this design is the trunnion which supports the screen surface. Rotation of this trunnion through an arc of 120° reverses the direction of flow over the screen surface. The screen surface itself has a radius of 30 in. and comprises 60° of the arc of a circle. Feed enters the feed distribution box through a standard pipe flange and flows to the adjustable feed spout. At this point it enters the screen surface in a tangential manner, undersize moving through the screen to the undersize discharge pipes, oversize passing off the end of the screen surface and flowing down through the screen oversize discharge chute.

This unit is designed to be operated with a slight positive pressure on the feed box although the unit can be operated with no pressure on the feed box. Normally for ease of control, pressures from one to five psi can be used. A variable feed spout is provided to insure proper distribution of the feed to the screen surface. In general, feed velocities to the top of the screen surface are in the order of 10 fps.

Applications

Data on four applications of the DSM screen are presented below:

Heavy Media

One of the most important applications of the screen to date has been in heavy media circuits.

Since 1950 the DSM cyclone heavy media process has been used extensively on the Mesabi Iron Range for benefication of low grade iron ore.

In general, these plants have operated satisfactorily on the —3/16-in., +65—mesh fraction for which they were designed. However, the most serious operating problems to date have been the high magnetite medium losses and the difficulty of maintaining a clean medium free of non-magnetics. Clean medium is necessary if sharp separations are to be realized.

The operators have made great improvements in the design and opera-

tion of these plants since the first units were installed. Initially, medium losses upwards of 15 lb of magnetite per ton of raw feed were reported, whereas in the more modern plants the losses have been reduced to approximately eight lb per ton of feed. Most of the improvement in medium consumption has been the result of finer screening, increased use of magnetic separators, more efficient washing of concentrate and tails, and the use of a higher medium to ore ratio.

In a typical DSM cyclone heavy media iron ore plant the cyclone underflow and overflow, which contain the concentrate and tails, respectively, along with associated medium, is drained on conventional wedge bar type vibrating screens with openings between the bars of ¾ mm to one mm. A typical size analysis and magnetics determination on the drain medium from a vibrating screen with ¾ mm opening between bars operating on cyclone overflow is shown in Table I.

TABLE I

Vibrating Draining Screen

Mesh	Magnetics % of Total	Non-Magnetics % of Total	Composite % Ind
48	0.23	9.65	9.88
65	0.18	3.34	3.52
100	0.79	2.28	3.07
−100	76.29	7.24	83.53
Total	77.49	22.51	100.00

From this data it is apparent that a large volume of the drained medium must be diverted to the cleaning circuit to remove the 22.51 per cent nonmagnetics to maintain the medium at the desired gravity.

The DSM heavy media cyclone plant where the above data was collected is designed with two identical units, each treating the same feed. To obtain operating data on the DSM screen which could be compared with the vibrating drain screen data, two 4 ft wide DSM screens were installed on the cyclone overflow from one unit.

At the time this article was written the DSM screen had been in operation for a short time. However, as shown by the data in Table II they have improved operation of the plant to a marked degree.

TABLE II

DSM Screen Draining

Mesh	Magnetics % of Total	Non-Magnetic % of Total	Composite % Ind
48	—	0.25	0.25
65	0.05	1.12	1.17
100	0.93	2.60	3.53
−100	87.89	7.16	95.05
Total	88.87	11.13	100.00

The DSM screen that was used in obtaining this data had 0.5 mm openings between the bars and a capacity of approximately 150 gpm per ft of width. This unit is shown in operation in Figure 4 and Figure 5.

In the circuit where the DSM screen has been installed, preliminary data indicates that the medium in the cleaning circuit has been reduced 30 to 50 per cent of the normal value. It was contemplated on the Range that a DSM screen would be installed on the cyclone underflow to further reduce the medium in the cleaning circuit.

By using DSM screens for draining and incorporating other minor changes in a DSM heavy medium cyclone plant it is believed that medium losses can be reduced substantially.

At the present time, magnetite is used exclusively in cyclone plants. However, in many cases ores requiring a substantially higher separating gravity is required to produce a marketable concentrate. With the high medium losses it has been necessary to use the cheaper magnetite (dry sp.gr. 4.7 to 4.9) and to operate with lower gravities instead of going to the more expensive ferrosilicon (dry sp.gr. 6.8) at higher gravities, percent solids of the separating suspension remaining the same. However, indications are that by using the DSM screen for draining, the use of ferrosilicon in cyclone heavy media circuits would be economically feasible, with its attendant advantages over magnetite.

Coal

In Table III data are presented showing the operations on coal.* This operation was with a two-ft screen with a surface having 2.0 mm (0.078-in. bar spacing.

TABLE III

Feed			¼ x 0 Coal
Feed Rate (gpm)			350
Feed (% solids)			18
Oversize (% solids)			67.5
Undersize (% solids)			7.8
	Size Distribution		
Mesh	Feed % Cum	Oversize % Cum	Undersize % Cum
8	44.04	84.80	0
10	56.46	93.18	1.94
14	65.13	96.01	22.48
20	74.21	97.87	36.95
28	80.07	98.22	52.45
35	86.28	98.52	70.54
Weight Distribution %	100.00	58.00	42.00
Size of separation (5%+in undersize)			1525 microns
Tyler Efficiency			91.0

* This type of equipment is marketed to the coal industry by Heyl & Patterson, Inc., under the designation, "H&P Sieve Bend."

Potash

In Table IV data showing the operation of a one foot DSM screen with 1.0 mm of (0.039-in.) bar spacing on potash flotation middlings is presented.

TABLE IV

Feed rate (gpm)	221		
Feed (% solids)	9.9	(33.1% K_2O)	
Oversize (% solids)	66.3	(57.4% K_2O)	
Undersize (% solids)	4.5	(3.9% K_2O)	
	Size Distribution		
Mesh	Feed % Cum	Oversize % Cum	Undersize % Cum
10	5.6	10.6	—
14	28.4	50.8	—
20	46.7	84.2	0.4
28	52.3	93.3	1.0
35	54.8	96.1	2.0
65	58.7	97.9	6.3
100	65.1	98.5	15.5
Weight Distribution %	100.00	56.7	43.3
Size of Separation (5% + in Undersize)			250 microns
Tyler Efficiency		96.9%	

Taconite

In Table V data showing the operation of a one foot DSM screen with 1.5 mm (0.059-in.) bar spacing on cobber tailings is presented:

TABLE V

Feed rate, gpm			137
Feed, % solids			17.4
Oversize, % solids			73.0
Undersize, % solids			12.7
	Size Distribution		
Mesh	Feed % Cum	Oversize % Cum	Undersize % Cum
8	2.40	12.33	—
10	7.17	36.52	—
14	14.12	61.51	0.55
20	22.14	77.80	3.88
28	29.55	88.62	10.42
35	35.81	93.17	17.04
48	41.18	94.96	23.55
65	45.96	95.95	29.58
150	50.01	96.57	34.93
Weight Distribution %	100.00	24.6	75.4
Size of Separation (5% + in undersize)			780 microns
Tyler Efficiency		91.55%	

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"The DSM Sieve Bend, Recent Developments in Apparatus for Wet Screening at Fine Sizes," *The South African Mining and Engineering Journal*, May 24, 1957

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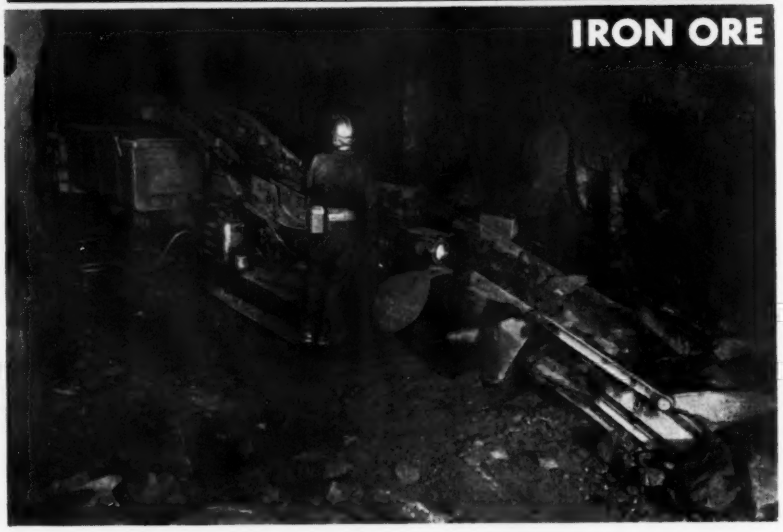

Some Uses in Rock Loading

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3. Driving through Rock Faults.
4. Grading Haulage Ways.
5. Driving Tunnels or Headings.
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• • •

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COAL DIVISION REPORT
First of two parts

Characteristics of A-C Mining Equipment

Advances in motor and control design, improvements in couplings and torque converters, and the great number of combinations of these now available mean that d-c motor performance can be duplicated by a-c motors

By F. R. Hughes, R. C. Berger,
J. A. Buss and A. C. Lordi

INTEREST being expressed by the coal industry in the use of a-c power has precipitated the need for a document describing the different kinds of a-c motors, control, and associated equipment available in industry today, together with a tabulation of their most important characteristics. This information will enable the mining industry to intelligently evaluate and compare these characteristics with d-c motors which have historically been the work horses of industry. It is the sincere hope of the several men who assisted in writing this report that it will be helpful in preventing troubles and misunderstandings during the transition from d-c to a-c.

Ever since the acceptance of a-c generation and distribution systems, the use of integral-horsepower polyphase induction motors has grown. This motor has achieved and maintained a leading position by virtue of its simplicity, ruggedness, and low cost. The standard line of induction motors includes not only the popular squirrel cage and very versatile wound rotor motor but also derivatives of these basic motors, including multi-speed induction motors.

The Squirrel Cage Induction Motor

The winding of a squirrel cage induction motor, to which the power supply is connected (usually the stator), produces a revolving magnetic field in the air gap. The field is approximately of sine wave form and revolves at synchronous speed. As the magnetic field revolves, the flux cuts the conductors of the winding on the other member of the motor (usually the rotor) and generates a current in that winding which, in turn, opposes the rotating generating, or primary, flux. The interaction of the stator and rotor fluxes produces torque and causes the rotor to follow the rotating primary flux.

If the secondary, or rotor, conductors are arranged like the bars of a "squirrel cage," and if the squirrel cage is arranged to allow its rotation, the force tending to move the conductors will rotate the squirrel cage. The uninsulated bars of the squirrel cage are embedded axially in the rotor iron close to the periphery and they are connected together through a suitable short circuiting ring at each end of the rotor. This single construction makes the squirrel cage motor the most rugged and the least expensive of all types of induction motors.

The squirrel cage motor is fundamentally a fixed or constant speed machine; however, the basic design of the rotor can be modified so as to vary slightly from a fixed speed motor. Variations in rotor design give variations in speed-torque curves, current-speed curves, power factor-speed curves and efficiency-load curves. The electrical industry builds three fundamental types of squirrel cage motors, each one having its own set of operating characteristics. These characteristics have been standardized and documented by the National Electrical Manufacturers Association, (NEMA) and are known as NEMA designs B, C, and D.

FOR GENERAL PURPOSE, SINGLE SPEED DUTY

NEMA design B is the general purpose single speed a-c motor with normal starting torque and normal starting current. It is the standard by which the characteristics of all induction motors can be compared. It is equipped with a low resistance squirrel cage winding which results in low "slip". The slip of an induction motor may be likened to the speed regulation curve on a shunt wound d-c motor. It is in effect the difference between no load and full load speed. A "slip" of zero is equivalent to 100 percent motor speed. A slip of 10 percent is equivalent to 90 percent motor speed and a slip of 100 percent would be equal to the motor at rest. In the NEMA design

B motor, the slip is about three percent at full load. Because the slip is low, the secondary losses are low, which gives the motor a high efficiency.

Normal starting torque of the design B motor ranges from 100 percent to 175 percent depending upon the size and speed. As the nameplate speed goes down for a given nameplate horsepower, the motor reactance increases, reducing the available percentage of starting torque. This means that a 900-rpm motor of a given horsepower rating will have less starting torque than an 1800-rpm motor of the same horsepower rating.

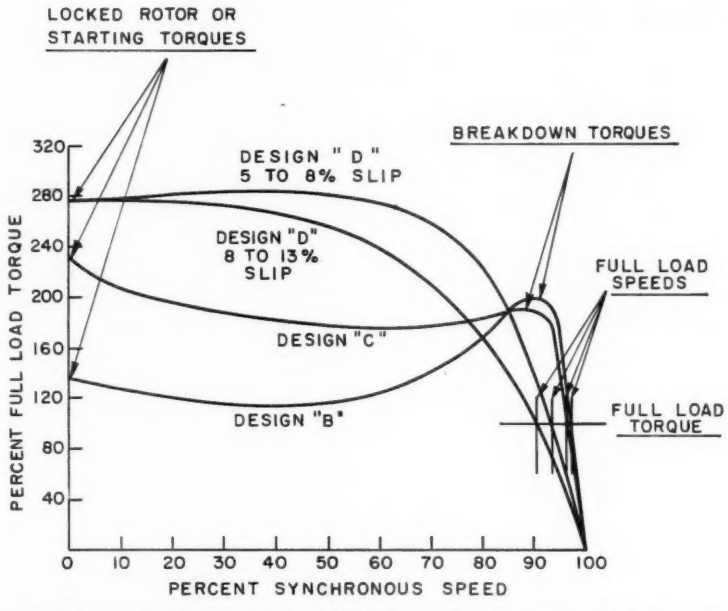
Likewise, as the horsepower rating increases for a given speed, the percentage starting torque decreases because the ratio of rotor resistance to reactance decreases and the torque created by the inphase component of current becomes relatively weaker. Therefore, a 100-hp motor will have less starting torque than a 10-hp motor, percentage-wise, for a given speed.

Breakdown torque will amount to about 200 percent for a design B motor, whereas the starting or inrush current will be of the order of six times full load current.

The cost of the NEMA design B motor is the lowest of all induction motors. Contributing to this is the simple rotor punching, together with the low cost that is achieved by the use of aluminum rotor bars cast integrally with aluminum end rings. This is particularly true in smaller motors. However, the need for high thermal capacity rotors on some mining machines may require the use of the brazed bar assembly.

NEMA Design B motors are preferred for those constant speed applications which do not require frequent starting or reversing and where they are not required to accelerate a high inertia load. However, special features of mining machine designs sometimes require that these preferences are relegated to second place in favor of other features which are more vital to the overall machine performance.

There are some applications, such as coal conveyors, where motors are always started under load. Since the starting torque of a NEMA design B motor is limited to about 150 percent of running torque, it may be desirable to consider a NEMA design C motor where starting torque may be of the order of 250 percent. In this case there would be comfortable margin over the break away torque of the load. Of course, a larger design B motor would do the same thing but then, in addition to being more costly, the over-sized under-loaded design B motor would be operating at a lower power factor and efficiency than would be the correctly sized, design C motor. This would mean that the operating cost would be higher for the design B motor.



Speed-torque characteristics of standard single speed squirrel cage induction motors (NEMA designs)

FOR GREATER TORQUE EFFICIENCY

The NEMA design D motor is known as a "high slip" motor. It is characterized by its high starting torque and low starting current. Two standard versions of this motor are built, one with a full load slip of five to eight percent and the other with a full load slip of the order of eight to 13 percent.

Knowing that the design D motor has high slip, it can be considered that this motor has high resistance rotor bars. It also has a lower running efficiency. Since the high slip causes high rotor losses, design D motors are usually built in a larger frame than the general purpose design B motor of the same horsepower and synchronous speed rating. Therefore, it can be concluded, the design D motor carries a higher price tag.

Starting torque and breakdown torque on a design D motor are about equal and range from 275 percent to 300 percent. The high resistance rotor also produces a relatively low starting current. It is on the order of 450 to 500 percent of the full load current.

With higher slip comes a greater amount of speed regulation, which makes the design D motor a poor choice for those loads requiring constant speed operation. The D motor is often termed a "variable" speed motor because its speed changes so widely from no load to full load.

The design D motor has a greater torque efficiency. It can be used to accelerate high inertia loads. It is suitable for frequent starting and reversing and, therefore, excellent for chain conveyors, traction drives, car dumpers and car feeders.

Many attempts have been made to compare the effects of voltage variation on the torque of a-c and d-c motors and much importance has been attached to the fact that the torque of an a-c motor varies as the square of the voltage applied to it, while a d-c series motor can deliver the same torque at low, or high, voltage as it delivers at rated voltage.

STANDARD INDUCTION MOTOR CHARACTERISTICS

NEMA DESIGN	"B"	"C"	"D"
General Classification	Normal Torque Normal Starting Current	High Starting Torque, Normal Starting Current	High Starting Torque, High Slip
Full Load Efficiency	High	Lower than Design "B"	Poor
Slip	Low 2 to 3%	Moderate 3 to 5%	High 5 to 13%
Starting Torque	130 to 170%	225 to 250%	275 to 300%
Starting Current	600 to 650%	550 to 600%	High in Percent of rated
Power Factor Full Load	High	Moderate	High

It must be remembered that the amount of torque which a motor delivers is determined by the load and not by the motor. Thus, for a reasonable variation in voltage, the a-c and d-c (series) motors will perform somewhat the same: speed is reduced by low voltage and increased by high voltage. In the case of the d-c (series) motor, the speed varies directly with the voltage if the torque required by the load remains the constant. That is, 50 percent voltage gives 50 percent speed, 100 percent voltage gives 100 percent speed, 125 percent voltage gives 125 percent speed, etc. In contrast, an a-c motor will never operate above its synchronous speed regardless of how high the voltage is and at low voltage its speed will be reduced, but not quite to the extent that a d-c series motor speed is reduced by low voltage. For example, an a-c motor might have 100 percent torque available at 77.5 percent synchronous speed and 70 percent voltage, or at 87.5 percent speed and 80 percent voltage, or at 97 percent speed and 100 percent voltage, or at 99 plus percent speed and 120 percent voltage, etc.

The importance of voltage variation on an a-c motor resides in the effect of voltage on breakdown and starting torques. Starting and breakdown torques vary as the square of the voltage applied to the terminals. Thus, 70 percent voltage will enable the motor to produce only 49 percent of the starting torque that is available at rated voltage or, expressing this in another manner, the motor can produce a starting torque of only 98 percent of full load torque when it is started at 70 percent rated voltage, as compared with 200 percent torque available when started at rated voltage.

By way of explanation, when the voltage drops, the stator inrush current, as well as rotor current, drops proportionally because of transformer action between the stator and rotor conductors. The stator provides the flux and, therefore, reduction in stator amps reduces flux. Thus, *both factors that produce starting torque are altered by a voltage change causing starting torque to vary as the square of the voltage.* This is probably the most important operating principle of induction motors to be remembered when applying them to underground mining machinery.

MULTI-SPEED MOTORS

While the squirrel cage motor is essentially a constant speed machine, many drives requiring speed adjustment can be handled satisfactorily and advantageously by "multi-speed" induction motors having 2, 3 or 4 definite operating speeds with the speed regulation of a single speed induction motor at each speed. Multi-speed motors are also used to accelerate, drive and decelerate high inertia loads. For accelerating duty, multi-speed motors are desirable as the motor power loss is much less than on single speed motors. The various speed combinations of multi-speed squirrel cage motors are obtained by: (1) single winding; (2) super-imposed windings, and (3) combination windings.

The single "consequent pole" stator winding may be reconnected by external control to give two speeds in the ratio of two to one. The lower of the two speeds is obtained from the higher speed winding by reversing the connections to alternate poles which as a "consequence" induces additional poles intermediate to the original ones. Doubling the number of poles in this way reduces the synchronous speed of the motor by one-half. The changing of poles is accomplished simply by reconnecting the six terminal leads connected to taps on the stator winding.

The superimposed, or additional, stator winding having the desired second speed may be added to the single speed motor windings. This method must be employed for all speed combinations not in the ratio of two to one. Whenever the speed requirements are two to one (3600/1800 or 1800/900 or 1200/600 rpm) a single sequent winding is usually employed in preference to the superimposed winding. The cost is lower, the size and weight of the motor is minimized and the efficiency at each of the two speeds is greater.

Combinations of the above two methods may be employed if more than two speeds are required. Speed requirements like 1200/900/720/600 rpm would require more than two windings. This becomes impractical and economically unsound, therefore, an adjustable speed drive should be considered under such circumstances.

Standard multi-speed motors include combinations of 2, 3 and 4 speeds with output ratings of constant horsepower, constant torque and variable torque. The single-winding two-to-one speed constant-torque motor is probably the most popular of all multi-speed motors.

The Wound Rotor Induction Motor

While the constant speed induction motor is inflexible with regard to modifications in speed-torque characteristics by control equipment, it is reasonably flexible to modifications based on relatively simple design changes as has been already pointed out. In contrast, wound rotor motor design is fairly well fixed and modifications to speed-torque characteristic is accomplished by means of external control equipment.

The wound rotor induction motor is an adjustable secondary resistance motor. This is accomplished by using a three phase rotor winding, similar to the stator winding. One end of each phase is brought out to a slip ring on the motor shaft. Through stationary brushes in contact with the slip ring, any desired value of resistance may be added to the secondary or rotor circuit. With the slip rings shorted, the wound rotor motor has a torque characteristic similar to a NEMA design B motor.

Breakdown torque or maximum torque of a wound rotor motor amounts to 200 to 250 percent of full load torque. The rotor winding by itself has a ~~very low~~ resistance ~~giv~~ing the motor, when operating at top speed, a low slip and high efficiency characteristic similar to a NEMA design B motor.

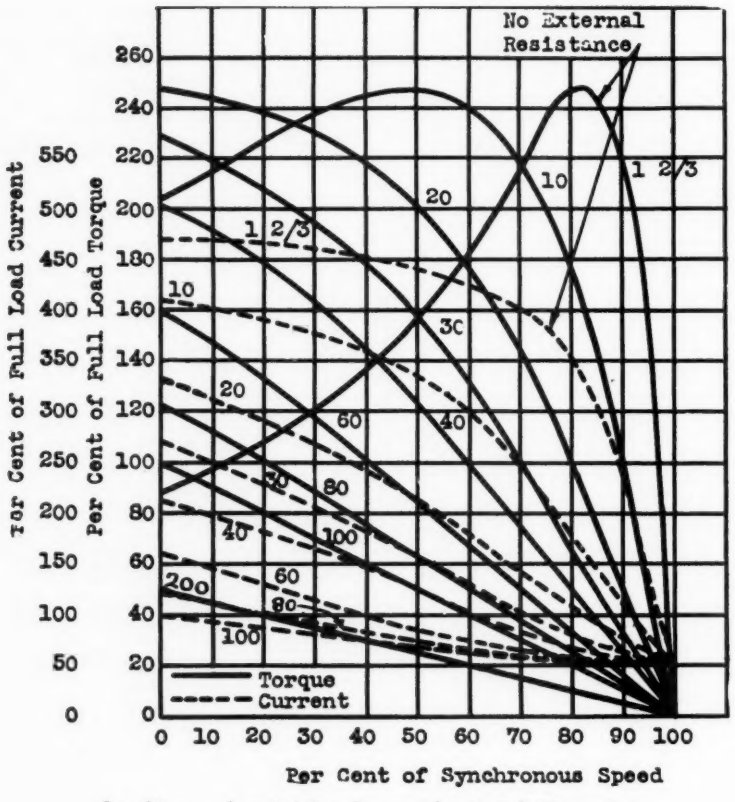
Performance of the squirrel cage induction motors (NEMA designs B, C, and D) is judged primarily by starting torque, starting current, and the amount of slip. With wound rotor motors the maximum torque is the chief criteria because starting torque and starting current, and the position of maximum torque and full load slip, are often controlled at will by the associated control equipment which inserts the desired amount of resistance in the external rotor circuit. Note that the value of maximum torque remains constant irrespective of the change in rotor circuit resistance.

If the short circuit is removed from the slip rings of a wound rotor motor, and if external resistance is added to the secondary circuit, it follows that the maximum torque will appear at a higher slip (lower speed). This shift in maximum torque position with change in rotor circuit resistance makes the wound rotor motor a most versatile type of induction motor.

ADJUSTABLE, VARYING SPEED MOTOR

The wound rotor motor is often referred to as an adjustable varying speed motor. For a given torque load the speed is adjustable by varying the amount of secondary resistance. For a given value of rotor circuit resistance the speed varies considerably with variations in load torque. However, at no load all of the motor torque curves pass through synchronous speed. *Therefore, at no load the motor would run close to synchronous speed irrespective of rotor external resistance.* This is an important characteristic of the wound rotor motor.

The wound rotor motor is more complex than the squirrel cage motor due to the wound secondary, slip rings, brushes and added control equipment, but it is still a rugged, moderately priced motor. It makes an excellent drive for severe loads, particularly for adjustable speed applica-



Speed-torque characteristics of a wound rotor induction motor

tions under these conditions. By merely changing the external resistance the speed at which a given torque is produced changes. With considerable resistance in the secondary, the speed torque characteristic is very much sloped back so that speed regulation is poor. Also under these conditions the efficiency of the drive becomes poor. On the other hand, if the load torque is small at low speeds (a fan load for example where the torque varies as the square of the speed), this does not mean much in actual power losses. Therefore, adjustable speed applications should be first limited to about two to one speed range and for best results they should be applied on such loads as fans and pumps. On the other hand, they can be successfully applied to constant torque loads (torque is constant at any speed) such as mine conveyors. Wound rotor motor drives are also successfully applied to mine hoist drives.

Although wound rotor motors lend themselves to adjustable speed applications, they can also be used on essentially constant speed applications where the power system is weak or where it is desirable to start a particularly large motor without disturbing the power system bus voltage.

With a suitable block of secondary resistance in the rotor circuit, the wound rotor motor can be made to produce 150 percent starting torque with only 1.5 times full load current and a reasonably good power factor. What really pulls down the voltage on a power distribution system is heavy current at poor power factor. Compared with the starting conditions of a squirrel cage motor, NEMA design B, where the starting current amounts to six times full load current at a power factor of 40 percent or less to obtain 150 percent starting torque, it is easy to see that the wound rotor motor is most attractive. The wound rotor motor can be accelerated by progressively cutting out the blocks of secondary resistance with minimum disturbance to the power line.

The wound rotor motor is also uniquely suited to applications involving lengthy operation in the accelerating and decelerating zone such as high inertia drives and frequent starting or reversing drives. As in the case of the NEMA design D motor the lower starting current removes the heating burden from the stator winding. However, instead of all of the secondary losses having to be dissipated within the confines of the high resistance rotor, most of the loss is dissipated outside the motor in a separate resistor. Of course, the rotor winding itself has some resistance and as such must dissipate some of the heat. Car dumpers, car hauls and traction drives with severe duty cycles are typical applications for the wound rotor motor, although considerably more control is required. This latter requirement may preclude the use of wound rotor motors on continuous mining machines because of the extra space required for the control.

Synchronous Motors

Polyphase synchronous machines have stators and stator windings similar to those of induction motors. Primary difference between the synchronous and induction motor lies in the rotor construction. For a machine to have synchronous characteristics, the rotor poles must remain fixed relative to the synchronous magnetic field produced by the armature windings. Therefore, there can be no voltage induced in the rotor windings by the stator under steady state conditions; and it is necessary to obtain the rotor field by the use of d-c excitation of the field poles. The d-c excitation is commonly supplied by a direct connected or belted exciter; however, a separate motor generator set or a metallic rectifier source of direct current is frequently used.

There are two general classifications of integral horsepower polyphase synchronous motors. These are the high speed synchronous motors and the low speed synchronous motor. The dividing line is 500 rpm, that is, motors rated 500 rpm and above form the high speed line and all motors below 500 rpm for the low speed line. Although there are only two standard lines, a complete list of electrical and mechanical modifications are available.

In accordance with NEMA classifications, the high speed synchronous motors are divided into two classes (1) general purpose and (2) large high speed. The general purpose motors include ratings of 20 through 200 hp 1.0 PF and 20 through 150 hp at 0.8 PF. The general purpose line also covers a speed range of 514 to 1800 rpm at 60 cycles. The large high-speed motors start at 200 hp for 0.8 PF and 250 hp for 1.0 PF and extends up to some 30,000 hp. Again, the speed range for this classification of motors is 514 to 1800 rpm but, in addition, all two pole motors (3600 rpm 60 cycle) regardless of horsepower or speed are included in this classification. These basic motors are all open and are rated 40°C. rise with a service factor of 1.15.

Starting currents range from 500 to 600 percent. Values down to about 400 percent may be obtained in many

instances if the torque requirements are reduced. Higher torques, up to 250 percent starting, 200 percent pull in and 350 percent pull out, are also available. It follows that with these higher torques the starting current will in general be higher.

Horsepower sizes up to about 1000 hp (depending upon speed) are built with end shield type sleeve bearings. The higher horsepower ratings are usually built with pedestal bearing type construction.

Synchronous Motor Torque Characteristics

High Speed Synchronous Motors	Percent of Full Load Torque	
	1.0 Power Factor	0.8 Power Factor
Starting & Pull in* Torque		
500 HP and below	110	125
Over 500 HP	85	100
Pull out Torque**		
200 HP (1.0 p.f.) 150 HP (0.8 p.f.) and below with 6 poles or more	175	250
All others	150	200
Low Speed Synchronous Motors		
Starting Torque	40	40
Pull in* Torque	30	30
Pull out Torque	150	200

* Based on Normal External Load WK^2 (inertia)

** Maximum sustained Torque which the motor will develop at synchronous speed for one minute with rated voltage applied at rated frequency and with normal excitation (NEMA).

Basic low speed synchronous motors are classified at speeds from 80 to 450 rpm (60 cycles) and with horsepowers ranging from 20 to 20,000 hp. Basic machines in the low speed lines are rated open 50°C. rise without any continuous overload capacity.

The starting currents range mostly between 250 and 350 percent. Higher torqures up to 250 percent starting, 175 percent pull in and 400 percent pull out can be obtained, but again these modifications are accompanied by higher starting currents in most cases.

Synchronous motors are usually used to drive motor generator sets, reciprocating and centrifugal rotory compressors, pumps, blowers, fans, crushers and pulverizers. Although they are sometimes used because of their synchronous speed characteristics, speed is usually not the primary reason for their application. Thus, as far as speed is concerned, synchronous motors are usually applied only where *low speed* and *high power* are the requirements.

ECONOMIC CONSIDERATIONS

INITIAL COST

There are a number of applications in which cost alone justifies the use of a synchronous motor. This holds true even though a d-c exciter and more expensive controls must be included in the cost. Whether or not a synchronous motor with exciter and control is cheaper than a squirrel cage induction motor with control depends primarily on horsepower and speed rating. However, there are other factors involved and so it is impossible to draw a definite dividing line on the horsepower chart and say that all ratings on one side will be cheaper as induction motors and all motors on the other side will be cheaper as synchronous motors. In general, however, the lower the speed, the lower the horsepower rating will be at which synchronous motor drives are less expensive.

POWER FACTOR

Another advantage of synchronous motors is that they operate at unity or a leading power factor and this improves the plant or mine power factor. There, of course, are other methods of improving power factor, such as the addition of static capacitors. However, in a wide range of ratings, power factor improvement can be obtained by the use of synchronous motors at less cost than by any other method.

For example, in ratings over 100 hp at 440 volts and speeds of 600 to 1200 rpm, 0.8 PF synchronous motors are less costly than induction motors plus capacitors to give the same correction. More important, in many applications is the flexibility and ease of adjustment of power factor that is offered by the synchronous motor. The amount of leading KVAR supplied to a mine's system can be changed simply by turning a rheostat governing the amount of excitation applied to a synchronous motor. This is in contrast to the more expensive and complicated "switching of capacitors" system required for comparable results.

EFFICIENCY

The unity power factor synchronous motor is generally about one to three percent more efficient than either a NEMA design B induction motor or a d-c motor having the same speed and power rating. Increased losses of the 0.8 leading power factor motor results in a lowered efficiency and, hence, is about equal to that of the induction motor in the higher speed ranges. The lower speed 0.8 leading power factor motors have a somewhat higher efficiency than do induction motors. The larger the horsepower rating, the more important efficiency becomes so that the larger sizes, and particularly at lower speeds, the efficiency factor alone may justify the use of the synchronous motor.

TORQUES

While with the induction motor, we were concerned with the lock rotor, or starting torque, the full load torque and the breakdown torque, in the synchronous machine we are primarily interested in the starting torque, the "pull in" torque and "pull out" torque.

Supplementary Equipment

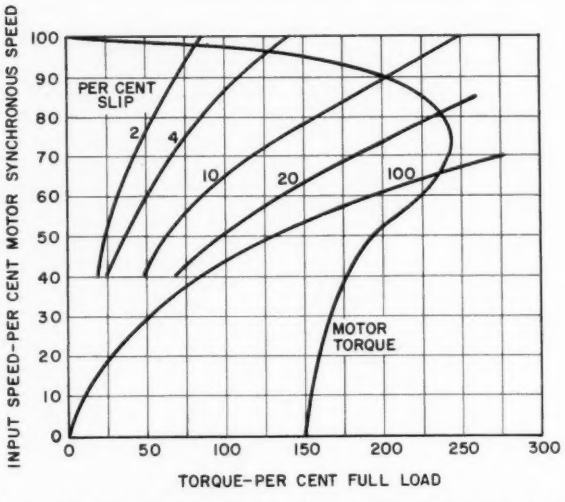
Losses dissipated by a squirrel cage induction motor during acceleration and plugging duty are well above those dissipated by d-c and wound rotor induction motors. There are no external resistances in the squirrel cage rotor circuit to absorb slip losses, so the losses incident to sub-synchronous speed operation are absorbed in the rotor. For example, in the acceleration from rest of an inertia (no friction) by a squirrel cage motor, the losses in a motor rotor are equal to the stored energy in the system. The change in slip has been from 100 percent to essentially zero slip. With a plug stop, three times the stored energy of the system is dissipated in the squirrel cage rotor (from 200 percent to 100 percent slip) and with a plug reversal, the value is four times the stored energy (from 200 percent to 0 percent slip). The addition of friction loading to the system further aggravates the rotor heating problem.

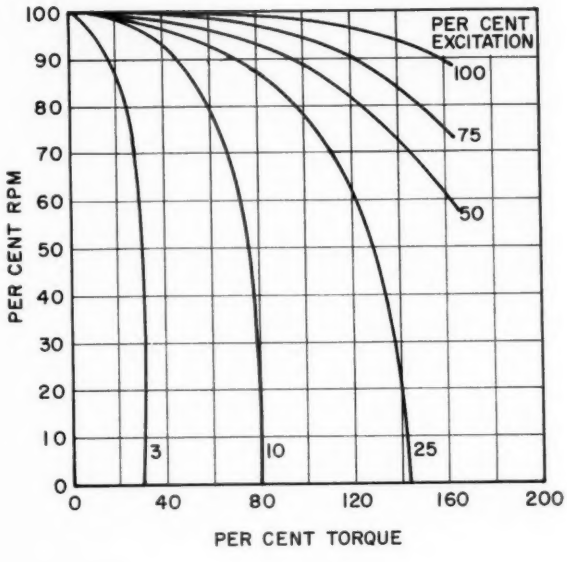
Supplementary equipment is available to partially absorb accelerating losses. This equipment also alters the characteristics of the drive motor. Three commonly used prices of supplementary equipment are:

A. Eddy current couplings
B. Fluid couplings and
C. Torque converters.

EDDY CURRENT COUPLINGS

An eddy current coupling consists of two members: the drum and the rotating electro-magnet. Either the drum or magnet may be the driven member. When excitation is applied to the magnet, any rotation of either the drum or the magnet causes eddy currents to be generated in the drum. This induced current sets up a second magnetic field whose strength is determined by the magnitude of the electromagnet's primary field and the relative speed between the drum and field assembly. The interaction between the primary field and the induced field causes one member to follow the other.





(Above) Typical hydraulic coupling characteristics. (Right) Typical eddy current characteristics

When load is connected to the output shaft of the coupling, the difference in speed between the drum and field assembly increases. The increased slip increases in the magnitude of the induced current and its resultant magnetic field strength. The greater attraction between these fields allows the coupling to transmit greater torque.

A stationary field unit which eliminates slip rings and brushes is sometimes used. The mechanical construction differs from the above unit, but the basic principle of operation still applies.

Under steady conditions, the output torque of the eddy current coupling equals the input torque even though input and output shaft speeds differ. The coupling at zero excitation allows the drive motor to accelerate to synchronous speed under no load conditions and only transmits torque to the load when excitation is applied to the coupling field. Any output speed, torque, or acceleration within the limitation of the drive motor can be controlled easily by varying coupling excitation in response to an error signal.

Normal operation of the eddy current coupling sets slip loss at full load in the order of four percent, corresponding to 96 percent efficiency. On drives under 100 hp where prolonged operation at high slips is not required the air-cooled coupling finds application. On larger drives, or on drives where operation with rated torque at reduced speeds is required, the water-cooled unit serves best to dissipate the coupling's losses.

An inherent feature of the eddy current coupling is the reduction of shock loading and vibration by the mechanical isolation of the drive motor and the electric damping of the eddy currents.

The application of the eddy current coupling has been on drives such as conveyors, feeders, fans, etc., where an infinitely adjustable speed is required. Motors can be started under no load conditions and the coupling can smoothly accelerate high inertia drives to preset speeds.

FLUID COUPLINGS

A fluid coupling consists basically of two members: an impeller and a runner. Either the impeller or the runner may be the driving member, as the fluid coupling is capable of transmitting power in either direction. Normally the impeller is the driving member and the runner is connected to the driven load. The impeller contains blades which throw a stream of oil against the blades of the runner. Power from the driving source is transmitted to the driven member through the kinetic energy of the moving oil.

As with the eddy current coupling, the input and output torques of the fluid coupling are equal and independent of coupling slip. However, the fluid coupling imposes an appreciable load on the motor at reduced speeds with the driven machine at stall. The slip at the coupling represents losses which are absorbed by the coupling. Couplings are generally selected to operate on the basis of 2 to 5 percent slip at full load, meaning coupling efficiencies of approximately 98 to 95 percent. Where prolonged operation at high coupling slip is anticipated, or where the coupling is applied on a duty requiring frequent starts, external fluid cooling means may be required.

A "dry fluid" coupling is available which uses small steel balls instead of oil as a torque transmitting medium. The centrifugal force of the rotating balls compact them against the driving and driven members. Increasing coupling speed increases the available torque from the "dry fluid"

COMPARISON OF EDDY CURRENT COUPLING, FLUID COUPLING, AND HYDRAULIC TORQUE CONVERTER

	Eddy Current Coupling	Fluid Coupling	Hydraulic Torque Converter
Torque Ratio = $\frac{\text{output}}{\text{input}}$	1	1	Approx. 1 to approx. 5
Efficiency	= Speed Ratio	= Speed Ratio	80 to 90% above Speed Ratio of 0.45
External Cooling	Air or Water	Oil to Air or Oil to Water	Oil to Air or Oil to Water
Reverse Power Flow	Yes	Yes	Only partial
Reduces Shock	Yes	Yes	Yes
Adjustable Speed	Easily adjusted and regulated electrically	Possible with change in oil level. Seldom used	Possible with change in blading and oil level. Seldom used
Application	Conveyors, fans, feeders, pumps	Conveyors, shakers	Traction drives, crushers, extractors.

coupling, much as is done by the oil filled coupling. However, at full speed and at rated torque there is no coupling slip. Thus, once a drive is up to speed, the coupling efficiency approaches 100 percent.

With a careful choice of coupling, the breakdown torque of a squirrel cage induction motor is available to start a load. With this increased torque available at start goes the inherent reduction of shock loading and vibration damping associated with the fluid coupling. These features are desirable on such drives as compressors, screens, some conveyors, fans, pumps, etc.

HYDRAULIC TORQUE CONVERTERS

The hydraulic torque converter is essentially a hydraulic coupling capable of multiplying torque much as gears do; that is, a torque converter is a transmission whose "gear ratio" is infinitely variable from slightly less than 1 to 1 to an approximate 3 to 1 for single stage converters. Some multiple stage converters have ratios of 5 to 1 on a torque basis. A pump, a turbine, and a reaction member comprise the basic parts of the single stage converter.

The torque multiplying ability of a torque converter is variable and not usually adjustable. However, some converters have provisions to adjust blade angles to alter a given converter's characteristic.

Power is transmitted largely in one direction only by the hydraulic torque converter. Its reverse characteristic does little to retard overhauling loads. Reversing of drive rotation usually involves the use of reversing gears and clutches. A lock-up direct drive feature is available to allow regenerative or dynamic braking.

A converter's output to input torque ratio varies smoothly from a maximum at zero output speed to nearly one at maximum output speed. Drive motors start initially under light load and pick-up load as drive motor speed increases. Torque multiplication takes place until the driven load reaches approximately the drive motor's speed. Thus, acceleration losses are absorbed by the converter to a great extent, allowing the motor to accelerate faster, and by means of the torque multiplication, accelerate the load in less time.

Hydraulic torque converters have a relatively high efficiency at reduced speeds as compared with other slip devices. As with the eddy current and fluid couplings, external oil cooling may be required where prolonged operation at high slips is required.

Like the fluid and eddy current couplings, the hydraulic torque converter also inherently reduces shock and vibration by the mechanical isolation and viscous damping of the drive motor and driven load.

The principle application of the torque converter has been on traction drives, where high stall and accelerating torques are repeatedly required. Other applications include such high inertia loads as crushers and extractors.

Insulation

A discussion on a-c equipment is not complete without some information on motor insulation, their types and limitations.

Insulation systems are divided into classes based on their heat-aging characteristics. Experience has shown that certain insulating materials deteriorate rapidly above a certain operating temperature. Insulating materials, therefore, are grouped in accordance with a maximum operating limit to give a reasonable long life under normal operating conditions. In general, for every 8° to 10°C over the temperature limit, the life of the insulation will be cut in half. For example, a motor operating 20°C over the limit would have only one-fourth normal life. Materials used in motor insulation systems are classified in three categories:

CLASS A materials consist of cotton, silk, paper, and similar organic materials impregnated with natural or synthetic organic binders or varnishes.

CLASS B materials consist of mica, asbestos, fiberglass and similar inorganic materials with natural or synthetic organic binders and varnishes.

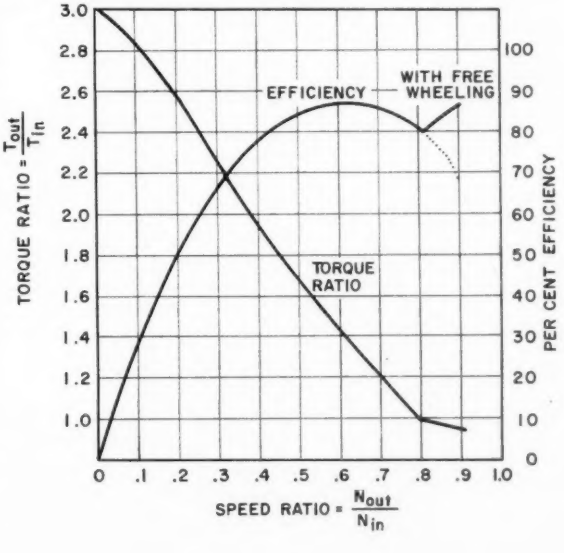
CLASS H materials consist of mica, asbestos, fiberglass and similar inorganic materials with binders or varnishes composed of silicone compounds or materials, with equivalent properties.

Class A insulation materials are most widely used because of lower costs and user preference for cooler machines in general. Classes B and H have the advantage of providing the designer more freedom in providing special motors, particularly when space or weight are important factors. Motors with Class H insulation, which allows maximum temperature rise, introduce some additional problems. Bearing and lubricant life and expansion must be given further study in the motor design. Surface temperatures on such motors may be high enough to require special precautions to prevent contact by operating personnel.

Class H insulation may be used to further enhance the inherent advantages of a-c induction motors over d-c motors in the areas of motor life and size and weight. When full measure is taken by the designer of the higher permissible operating temperatures of Class H, an increase in the continuous horsepower rating of as much as 30 percent above Class A or 15 percent above Class B may be possible in the same physical dimensions. On the other hand, if the designer chooses to accept Class A or Class B operating temperatures, the use of Class H insulation will greatly increase the life of the winding. At times the designer may choose to combine the features of temperature and size to attain the optimum balance of rating versus life for a specific design.

In contrast to the excellent results obtained through the use of Class H insulation in a-c induction motors, the record for totally enclosed d-c motors is modified by certain qualifying statements.

At present, the operation of silicone-insulated, totally enclosed d-c motors at full Class H temperatures (above 125°C rise) results in reduced brush life. Excessive brush wear results in a carbon dust deposit which may cause surface creepage failures. The brush wear and creepage problem is greatly reduced by internally ventilating the motors with fresh air or by operation of the totally enclosed machines at reduced temperatures (75°C rise).



Calculated performance curves for a 10-in. hydraulic torque converter

Blasting With Ammonium Nitrate

A Manufacturer Tells How It Can Be Done

By DORT TIKKER
Inorganic Chemicals Division
Monsanto Chemical Co.

AMMONIUM nitrate has been used as an ingredient in explosives for many years. During the last several years ammonium nitrate has been used as an explosive without compounding and packaging. The large tonnage of this product produced for fertilizer use provided a ready and inexpensive source once the technology was advanced enough to take advantage of its availability and low cost. Ammonium nitrate has been used as an explosive in two ways:

1. As an extender and gas former to supplement a high explosive, such as TNT or nitroglycerine
2. As a low-speed, low-cost explosive

In the second instance, ammonium nitrate was mixed with carbon black, sulfur, sawdust, or other such combustibles to form more gas from excess oxygen available in an ammonium nitrate decomposition reaction. When this second type of explosive is detonated, the speed of detonation is approximately that of ammonium nitrate.

A totally different manner of using this product as a high explosive is now being practiced. When fuel oil (approximately six percent by weight) is mixed with ammonium nitrate, the decomposition reaction is changed. The fuel oil is apparently in such close physical contact with the decomposing and reacting ammonium nitrate that it enters into the primary or first decomposition reaction.

This conclusion is drawn for two reasons:

1. The speed of the decomposition reaction is raised from 2000 meters per sec for ammonium nitrate plus dry additives to 4000 meters per sec for ammonium nitrate and fuel oil.
2. The self-propagation limit can be lowered from a nine-in. minimum diameter to approximately a 2½ -in. diameter when fuel oil is used.

This property of fuel oil to change ammonium nitrate from a low-value explosive to a high-value explosive at virtually no extra cost explains the popularity and acceptance of the method.

"Overdrive" Boosts Detonation Rate

The term "overdrive" describes that property of explosives which enables them to detonate at a rate greater than their self-propagating detonation rate. If, for example, a mass of explosive which detonates at 7000 mps is set off in contact with an explosive which detonates at 4000 mps then the slower explosive can decompose at a rate higher than 4000 but lower than 7000 mps for given distance. This distance is short. Therefore, as much of the ammonium nitrate must be as close to a higher rate detonator as possible in small diameter holes. This is done by taping primers to the primacord or dropping a cartridge of dynamite into the hole at definite intervals until the proper percentage of primer by weight is obtained. The preferred method is to use a continuous strand of heavy Primacord designed specifically for this purpose of overdrive detonation.

If this principle is considered when ammonium nitrate is detonated, the detonation rate can be raised from approximately 4000 to over 6000 mps. Hard rock usually needs a shock of 5000 mps in order to be shattered well. For maximum value from ammonium nitrate and fuel oil, an overdrive detonating system should be used. This method of detonation gives excellent results in a variety of strata from granite or hard limestone to soft shale. It has been shown that by

When oil (six percent by weight) is added to ammonium nitrate, two advantages are gained over mixtures using dry combustibles such as carbon black, sulfur or sawdust—detonation rate is doubled and a much smaller column of explosive self-propagates satisfactorily

varying primer strength and percentage of primer by weight, ammonium nitrate performance can be varied to act characteristically as the primer acts. That is, it will give results comparable in all respects, and better in most, to those that would be achieved if the hole was shot with all primer. By using a continuous column detonator such as a heavy Primacord, the entire mass of explosive detonates at the highest possible rate.

Addition of Fuel Oil Enhances Characteristics

A great many explosives users categorized explosives into fast explosives with low gas production or slow explosives with high gas production. To some extent, this was a valid working premise. However, the categorization by these characteristics has caused some confusion when ammonium nitrate is described. Ammonium nitrate can be detonated at a high rate, but this enhances its already remarkable gas production. Ammonium nitrate and fuel oil detonated at a high rate provides both exceptional shattering power and the lifting action of high gas production desired in some blasting operations. The explosives user is able to obtain for the first time this unique action in an explosive which delivers the best function of both types of fixed explosives. By using this very inexpensive but effective detonating method developed by Monsanto Chemical Co., the diameter of the hole ceases to be a limitation on the use of ammonium nitrate and fuel oil mixtures. It should be noted, however, that the larger the mass of nitrate, the more efficient the detonation. Monsanto suggests the use of this system in holes down to approximately three in. in diameter.

The company has done substantial work on physical factors which affect explosive efficiency and has designed its product to take advantage of the optimum in physical properties. Specific physical properties of Monsanto's Ammonium Nitrate Prill which give definite value are: (1) prill size distribution range, (2) average prill size, (3) oil content, and (4) density of the prill mass.

It can be safely said that high density (per se) is not to be desired. High density is of value in fixed explosives, especially in smaller holes, for the purpose of obtaining maximum work from each foot of hole drilled. However, it is very difficult to obtain reliable detonation from dense ammonium nitrate in oil mixtures. A relatively light, porous prill will perform substantially more work than a dense ammonium nitrate. In ammonium nitrate and oil mixtures there is a definite efficiency curve determined by the prill surface, to available air, ratio. Specific prill size is not as important as the prill size distribution range. Although the company has determined an optimum prill size, the largest gain in explosive performance comes from taking out those sizes over and under the optimum prill size range. A uniform, relatively small prill seems to be optimum for explosives use. It has been found that the amount of fuel oil retained by the prill is very important. There is a rather sharp curve peaking at six percent by weight of fuel oil calculated on the weight of prilled ammonium nitrate. Fortunately, most prilled nitrate will retain just about this amount of fuel oil if it is wetted by 10 percent of fuel oil and then allowed to drain for a half hour or so before being poured into the hole. There is a definite damping effect on the explosion if 10 percent or more of fuel oil is trapped in or retained on the nitrate at the time of detonation.

The explosive users now utilizing the data just discussed have shown marked savings over all other systems of blasting. The ammonium nitrate is used to full advantage in that more work is performed per dollar spent for explosive material. This method and product combination utilizes to the fullest extent the potential value in ammonium nitrate.

A continuous strand of specially-designed heavy Primacord is a good way to raise the rate of detonation above the self-propagation limit in a column of ammonium nitrate

Simple Precautions Should Be Taken

In order to prevent possible mishandling of such a common chemical, a review of some basic safety factors pertaining to ammonium fertilizer is as follows:

1. **Ammonium nitrate should be handled much as one would handle materials such as gasoline. Under all normal circumstances and due care, the material is completely safe to handle.**
2. **Under conditions of extreme heat, (several hundred degrees F) confinement, or open flame, ammonium nitrate can be dangerous.**
3. **Ammonium nitrate is not particularly flammable, but burns intensely when set on fire.**
4. **It should be stored in a building with good ventilation.**
5. **It should never be stored in a building capable of confining gases, such as a stone or concrete building with small windows.**
6. **It must never be contaminated with unknown materials or with materials not specifically recommended by the manufacturer of the nitrate. This is extremely important as a number of rather common substances may cause unpredictable reaction conditions if mixed with ammonium nitrate.**
7. **The dangerous mass limit of ammonium nitrate is 123 tons. At this level a fire can spontaneously change to a detonation. Therefore, each and every stock of 40 to 50 tons should be separated by at least six ft of space and a light metal partition such as corrugated sheet iron.**
8. **This material can produce oxides of nitrogen while burning. It is suggested, therefore, that an automatic sprinkling system with an overhead storage tank for water, or at least some hose with a pressure great enough to reach the fire without unduly exposing the fire fighters to the fumes generated by the burning nitrate, be installed.**
9. **Flooding with water is the only effective way to fight a nitrate fire as the nitrate has its own built-in oxygen supply.**
10. **Always keep loose nitrate from broken bags carefully swept up so ammonium nitrate dust is not present in the storage area. The dust, of course, is flammable.**

In summation, this material is not hazardous if three things are kept in mind:

1. No contamination unless specifically recommended.
2. No confinement or excessive heat (flame).
3. No storage over the critical mass (123 tons).

Use of the bulletin on Ammonium Nitrate published by the Manufacturing Chemists' Association (246 Woodward Building, Washington 5, D. C.) for further information on handling and storage is recommended.

A User Says

"HERE'S HOW WE DO IT"

By L. E. SNOW
General Drilling and Blasting Foreman
Utah Copper Division
Kennecott Copper Corp.

CONVERSION to the use of commercial grade ammonium nitrate (CGAN) for use in blasting at the Utah Copper pit of Kennecott Copper Corp. has presented unique problems for the Drilling and Blasting Department. In order to better understand these problems, a brief picture of the Bingham pit and mining method might be helpful.

The topographical features of the mine, a familiar sight to thousands of tourists annually, resemble a huge amphitheatre, carved out of the mountain. The top levels average 70 ft in height, while the sub-pit levels are generally held to 50 ft in height. With the development of each new low level, all encircling levels and switchbacks must be mined back in order to maintain safe working slopes.

Some quarter of a million tons of ore and waste must be blasted daily in order to keep 38 electric shovels operating. All material is blasted by "toe holes" of 24 to 28 ft in depth, drilled from prepared drill grades and sloped so as to bottom approximately five ft below the bench level. Horizontal spacing of these holes averages 22 ft except where faults occur in the bank. These "toe holes" are drilled by four-in. drifter machines, mounted on self-contained mobile drill units using three-in. starter bits and bottoming at a minimum of 2½-in. in diameter. "Toe-hole" drilling amounts to about two-thirds of the total drilling.

In the higher bank sections of the mine, and wherever necessary, single rows of "down holes" are drilled to 28 ft in depth and spaced, on the average, 23 ft apart. These holes also are drilled by a mobile drill. "Down-hole" drilling amounts to about one-third of the total drilling.

A complete mobile loading machine consisting of a truck, compressor, powder-blowing machine, diesel fuel tank and hose reel is in service at the Utah Copper pit, and has allowed the mine to take full advantage of ammonium nitrate as a blasting agent

Nitrate With Dry Additives Tried First

The powder previously used in the loading of "down-holes" was a free-flowing Hercomite bag powder which was detonated by one stick of Gelamite #1 attached to Primacord. Where water existed, Gelamite #1 stick powder was used for the entire loading because of its better water-repellent characteristics.

Gelamite #1, having a 65 percent weight strength, wrapped in 1¼ by eight-in. waxed paper cartridges, was used in springing and loading of all "toe holes." A minor amount of Gela-

mite was required for secondary blasting, trimming banks, springing "down holes," occasional loading of extremely wet "down holes," and for all primers. A total of 6,672,350 lb of Gelamite, or 76 percent of all powders used, was consumed during 1956. The powder factor for that year was 9.99 tons of material broken per lb of powder used.

Over the years, considerable testing of different type powders has been carried on in an attempt to improve blasting results and safety by substituting less sensitive explosives.

The first experiment with ammonium nitrate powders was made in 1955 in which Hercules EP-167 (Tritex) bag powder was substituted for the Hercomite bag powder in "down holes." This powder consisted of 95 percent ammonium nitrate, plus five percent coal dust and resins. In a joint experiment with Hercules Powder Co. representatives, they recommended a primer charge of 25 lb of Hercules Gelamite #1 stick powder per hole in order to obtain complete detonation. In detonating Hercules powder, only one stick was required. Due to relatively small price savings, larger primer charge, and inconsistent results, this powder was not adopted.

During 1956, in another joint experiment, Hercules EP-197B, a similar powder in which the coal dust had been replaced by wax, was used. Results being favorable, this powder in turn replaced Titan bag powder which, in the meantime, because of its lower sensitivity, had replaced Hercomite.

Savings and Safety Attract Interest in CGAN-Oil Mixture

Early in 1957, commercial grade ammonium nitrate (CGAN) became available from the new nitrate plant of the Geneva Steel Co. at nearby Provo, Utah. The price differential between this and bag powders offered an attractive potential savings. The insensitivity of the CGAN also offered substantial safety features.

Tests to date have proved ammonium nitrate can be substituted for higher-grade explosives on a pound-for-pound basis. In the scene pictured here note the excellent fragmentation obtained from a nitrate blast

The first testing of one ton of CGAN was made by loading the 80-lb sacks (soaked with three qt of fuel oil) into "down holes" that had been primed with 30 sticks of Gelamite, and blasted with Primacord. The success of this, and subsequent tests blasts, led to complete conversion to ammonium nitrate powder for use in all dry "down holes." Gelamite stick powder continued to be used for loading wet "down holes." While considerable variations in methods of loading "down holes" still exist for experimental purposes, the following conclusions are noted:

The fuel oil, at the rate of one gal per 100 lb of CGAN, should be added to the top of sacks as early as possible, allowing time for complete diffusion of the diesel oil. The ammonium nitrate dries, somewhat, and is then easily poured into the "down holes." The practice of loading dry ammonium nitrate into "down holes," followed by pouring fuel oil, is discouraged since several missed holes have resulted while using this procedure. Subsequent tests using our mobile powder blowing equipment have proven the advantage of machine mixtures of the charge.

Various methods of priming blast holes have been tried, including a high Primacord charge of PETN material in the form of Hercules XC-51 primer stick. These primers did not prove reliable and, therefore, a return was made to the Gelamite primer in which the number of sticks were reduced to a standard of 15 sticks (or about seven lb), regardless of the powder load.

Mobile Loader Increases Efficiency

Having successfully substituted CGAN for bag powder in the "down-hole" blasting, attention was then given to the possible conversion to this cheaper powder in "toe-hole" blasting. Larger potential savings seemed possible, due to the greater amount of the relatively higher cost Gelamite powder being used in the "toe holes." Toward this goal, a powder-blowing machine that had been taken out of service a decade ago, (due to the hazard created in blowing nitro-glycerine powders), was overhauled and put into service. This aided in the development of a self-contained mobile blowing unit. It was felt that by eliminating the hazard of a possible concentration of nitroglycerine, through the use of less sensitive CGAN, the objections to blowing powder into holes would be eliminated. The State Mine Inspector, Union officials, and Safety Department men were assembled to watch men of the Drilling and Blasting Department blow the ammonium nitrate powder into the "toe holes."

Since all compressed air lines had been eliminated with the advent of the mobile drill unit, it was necessary to use these units as a source of compressed air for the powder-blowing machine. This was accomplished through the use of reducing valves and/or trigger valves to furnish 35 to 40 psi air pressure. With this air

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Laurence E. Snow, general drilling and blasting foreman, started with Utah Copper Co. in 1922 as a flotation helper at the Arthur mill. He held subsequent positions with the West End Mining Co. of Nevada; was general mine foreman and mine superintendent of the Utah Apex Mining Co. in Bingham Canyon, Utah; served as mine superintendent of the Copper Canyon lease of the I.S. & R. Co. of Nevada, and did mine examination work for that company. A mining engineering graduate of the University of Utah, Snow was rehired at the Utah Copper Division of Kennecott Copper Corp. in 1950 as research engineer. In 1951 he was advanced to assistant drilling and blasting foreman, and in 1953 to his present position.

source, the powder-blowing machine is so placed on the ground that four to five holes can be reached by the load lines.

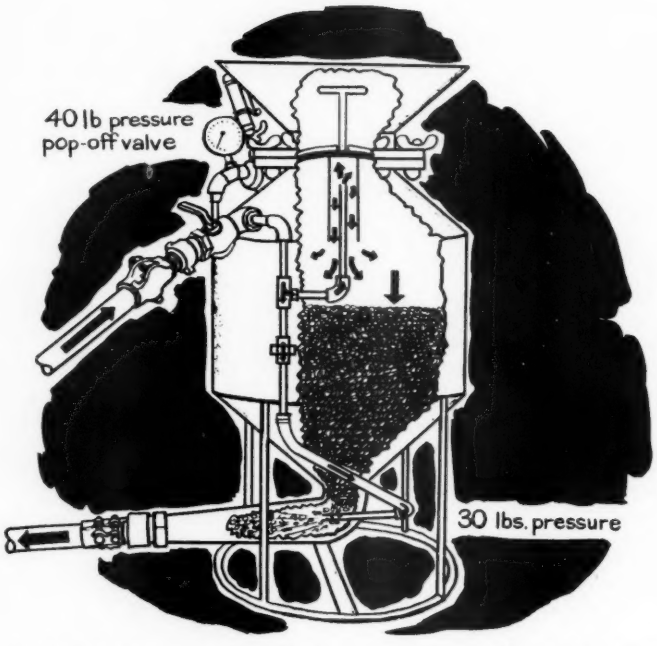
As a further step toward a complete mobile loading machine, a four-wheel drive truck, equipped with a 125 cfm rotary compressor, powder-blowing machine, disel fuel tank, and hose reel, has been put into service. Results to date indicate that the planning for complete coverage of the "Hill," through two or three mobile loading units, is practical.

Various methods of getting the "prilled" ammonium nitrate and the diesel fuel in proportion of one gal per 100 lb of powder have been tried. Currently, one gal of diesel fuel is forced through the measuring cylinder and small diameter hose to spray the dry CGAN (prills) near the hole at the connection to the load pipe. This allows for 100 pounds of dry prills to be blown through the powder blowing unit. The flow of oil is synchronized with the rate of flow of the dry prills which approximates 100 lb per 110 sec. The hopper on top of the powder allows for storage of prills which automatically drop into the loader following explusion of the batch load of prills, thereby speeding up the operation. One man operating from the bed of a truck feeds materials into the system while his partner controls the loading from the ground. The closed fuel system, plus the blowing of the dry prills, has resulted in a neat, simple and safe operation.

In order to obtain maximum efficiency of the mobile loader, advance planning is necessary in determining dry-hole areas and in having a sufficient number of these dry holes sprung (chambered) properly for the desired powder charge. Every effort is made to load and blast the same day. Some ground, after chambering, tends to cave if left overnight, and in this type of ground it is necessary to complete priming and loading soon after springing (chambering) is finished. In the harder ground section of the mine, it is necessary to make several spring blasts in order to obtain the desired chamber size for the powder load. It may be that the last spring of 50 lb of Gelamite can be eliminated, due to greater density of CGAN, as compared to the load of Gelamite in the 1¼ by eight-in. waxed paper cartridges—the total load being the same for both types of powder.

Consumption Increased to 60 Percent of All Powder Used

For obvious reasons, and since the CGAN is readily soluble in water, the wet holes encountered must be loaded with the 1¼ by eight-in. waxed paper cartridges of Gelamite at present, but considerable thought is going toward the solution of this problem. The percentage of wet holes will vary according to season and location.



A schematic diagram of the powder-blowing machine used for quick loading of blastholes: use of this efficient type unit is feasible because of the insensitivity of ammonium nitrate

In the past, powder has been delivered to the mine by rail car and distributed to the various level magazines. From these magazines, it was handled on rail by means of hand push-car. In contrast to this method, truck transportation from Geneva Steel's nitrogen plant is utilized. A twenty-ton trailer load is delivered and parked at 6190 level of the mine. From this location, powderblowing trucks deliver it to the various mine locations, the majority of deliveries going directly to the working places rather than to the level magazines. It is felt that the truck system offers considerable savings.

Results of the experiment to date have proven that the substitution of commercial grade ammonium nitrate (CGAN) powder for the Gelamite and Hercomite powders can be made on a lb-for-lb basis, resulting in a powder factor of about 10 tons of material broken per lb of powder used. At the 1957 yearly rate of 83,000,000 tons of material mined, the powder consumption was in the neighborhood of 8,300,000 lb.

There was a rapid increase in the monthly consumption of CGAN from the start of the experiment in the spring of 1957 up to approximately 60 percent of all powder used at the present time. The remaining 40 percent is stick powder used for springing (chambering) all holes, priming all holes (at 15 sticks per hole), loading wet holes, "pot-holing" banks, and secondary blasting. A good deal of experimental secondary blasting of boulders with the use of CGAN diesel fuel mixture has taken place, and it now appears feasible to extend the use of CGAN to a minimum charge of 10 pounds detonated with as few as four sticks of powder for primer. The use of CGAN is gradually being extended into other fields such as in loading "damp" holes and for limited uses in springing (or chambering) holes.

A substantial savings in powder costs has been realized and there are companion savings indicated from a comparative study made of the manhours required to complete springing, loading and blasting of 125 "toe holes." The holes blasted per manhour worked was 0.271, as compared to the 1956 yearly average for "toe holes" of 0.235 per manhour worked. This is a 13.3 percent savings in department blasting labor.

In addition to the tangible savings, there are safety features which enhance future use of CGAN. The company has reduced the manhours of exposure by increasing springing and loading efficiency. The employees, being further removed from the "toe" of the bank, are working in a less hazardous location. Easier handling of a less sensitive powder has also been experienced.

In conclusion, the mobile powder-blowing truck has allowed the Utah mine to take full advantage of this revolutionary blasting agent.

Operators' Corner

AUTOMATIC

COAL PROPORTIONING SYSTEM

FOR many years the Vesta and Shannopin mines at East Fredericktown, Pa., have supplied a major portion of the high grade metallurgical coal necessary for coke production at Jones & Laughlin Steel Corporation's plants at Aliquippa and Pittsburgh, Pa. After mechanical loading facilities were installed during World War II, the Vesta-Shannopin operation was enlarged to include complete preparation facilities, making it one of the world's largest coal preparation plants. The latest addition to this mechanization program has been the construction of facilities for mixing coal from the Shannopin mine up stream on the Monongahela River with the output of the Vesta mine.

Mixing of these two coals is regulated by a completely automatic weighing and proportioning system. After several months operation the proportioning system has proved completely successful in controlling the mixing in spite of variations in the Vesta flow.

Prior to the installation of the continuous proportioning system, coal from both the Shannopin and Vesta mines was transported down the river by barges directly to the mills. It was decided that the entire operation could be streamlined and operated more economically by mixing the outputs of the Vesta and Shannopin mines at the East Fredericktown preparation plant—and then transporting the mixed coals by barge to the mills. Following this decision, consulting engineers were engaged to design and construct the necessary facilities at East Fredericktown. Automatic weighing and proportioning equipment was required, and after investigating all possibilities, an electronic system, engineered and built by the Trans-Weigh Co., Wayne, Pa. was selected and installed.

A simplified flow diagram for the two types of coal up to their junction point is shown in figure 1. High volatile Vesta coal from the local mine is unloaded by two rotary dumps into a common hopper. After initial screening and crushing in a chamber approximately 170 ft below ground, an apron feeder transports the coal above ground at an average rate of 1300 tph. The coal is then carried across a suspension bridge spanning the Monongahela River on a belt conveyor about 2000 ft long.

There is very little storage capacity in this phase of the system—costs for bins, feeders and the like to provide extensive capacity were prohibitive. Lack of adequate storage capacity made it impractical to provide minute-to-minute control of the primary flow.

SHANNOPIN COAL FROM MINES UP STREAM

Shannopin coal is unloaded from barges and transported by belt conveyor to ten bins having a total capacity of about 5000 tons. Ample storage capacity was chosen to permit two-shift operation of the preparation plant with one-shift unloading of the barges. Since there is always excess coal available, accurate proportioning can be accomplished by controlling the flow rate of the Shannopin in proportion to the Vesta coal.

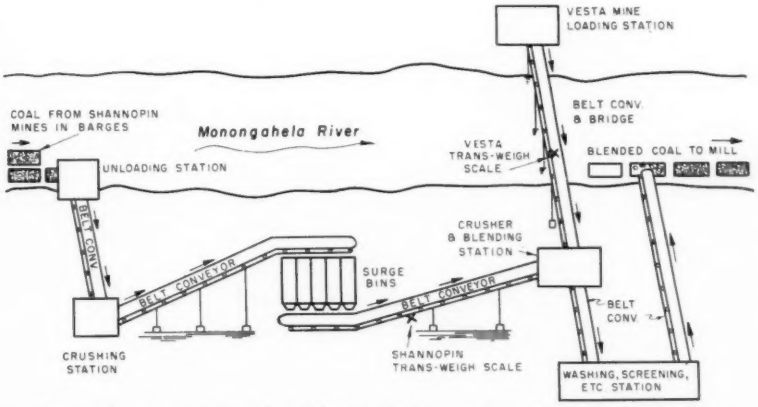


Fig. 1. A uniform quality of coal feed to the preparation plant is obtained with an electronic continuous proportioning system that blends coal from the Shannopin mines with a variable flow of coal from the Vesta mines

Each bin is equipped with a belt feeder—speeds of all feeders are controlled together by one rheostat—but up to five of the feeders may not be in use at any one time. A collection belt carries the Shannopin coal from the feeders at an average rate of about 600 tph to an inclined conveyor that in turn transports the material to the jointure of the two flows. The resulting mixture of Vesta and Shannopin coals is then conveyed to the preparation plant for final processing.

OPERATION OF MEASURING SYSTEM

A typical basic Trans-Weigh measuring system is illustrated in figure 2. This system measures the weight of material on a short section of the belt, and also the belt speed, and then multiplies these two variables electronically to obtain the pounds per hour being delivered. The three primary components of this system include (a) an electric tachometer generator driven by the return belt which measures belt speed and supplies current to the weighing system; (b) an electric strain gauge load cell which measures the belt load; and (c) a specially modified electronic potentiometer which indicates and records instantaneous rate of flow and also includes an integrator which displays totalized tonnage on a small counter.

TIME LAGS THE SAME

In the Vesta-Shannopin coal proportioning system, the Vesta flow is detected by a Trans-Weigh scale comprising a load cell and tachometer generator located part way across the bridge, while the Shannopin flow is measured by similar scale located just after the loading point on the inclined conveyor. Location of the Vesta detecting devices was selected so as to make the time lags approximately equal between each scale and the junction point. Thus, when Vesta tonnage varies, the control system immediately affects a proportional change in the Shanopin feed rate, and the two changes meet at the junction point at the same time.

Both Vesta and Shannopin feed rates are transmitted to a central con-

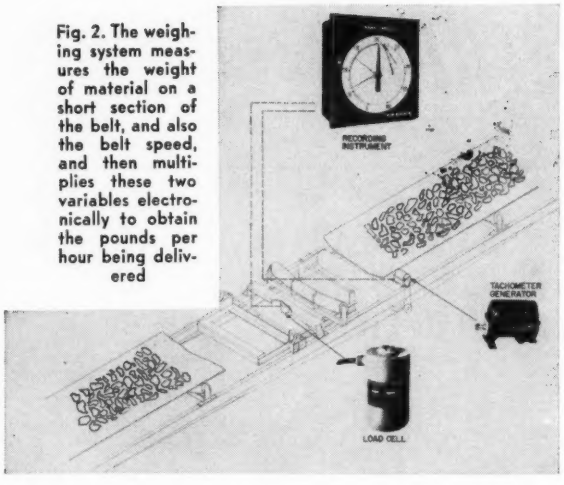
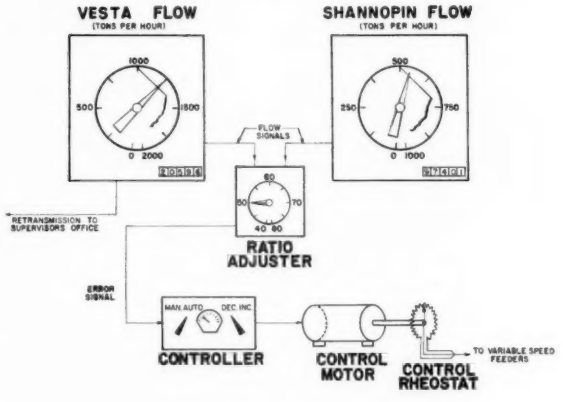


Fig. 2. The weighing system measures the weight of material on a short section of the belt, and also the belt speed, and then multiplies these two variables electronically to obtain the pounds per hour being delivered

Fig. 3. Schematic diagram of Trans-Weigh instrumentation for the Vesta-Shannopin coal proportioning system



trol station near the junction point. Primary output and totalized tonnage are also retransmitted about another 1000 ft to a duplicate instrument in the superintendent's office.

CONTROL ACTION OF VESTA-SHANNOPIN SYSTEM

The continuous coal proportioning system is shown schematically in figure 3. Automatic proportioning is accomplished by the following sequences: The operator sets the desired ratio of Shannopin to Vesta flow by a calibrated dial adjustment on the ratio adjuster. The ratio adjuster receives flow signals from the recorders proportional to actual measured feed rates. These measured and desired feed rate signals are compared and the difference is an error voltage which goes to the controller. The controller, through a motor and rheostat, then increases or decreases the speed of the feeders to bring the error voltage back to zero.

If the conveyors should stop, for example when the primary belt accidentally trains off to one side and trips a limit switch, the control motor is driven to the low-speed position by an interlock. Originally, it was assumed that the operator would switch to manual control when restarting the belts and bring the Shannopin flow up close to the desired value before switching to automatic. However, this step is not necessary, and the control is left on automatic. When the system is restarted the controller automatically brings the secondary feed up to the correct value without overshooting.

CHART RECORDS TELL THE STORY

Performance of the proportioning system is illustrated in figure 4 by segments of the instrument charts. Both segments are from 24-hour circular charts having 15-minute time divisions. The top chart section shows the Vesta or uncontrolled flow rate—the bottom section illustrating Shannopin flow.

Variations of ten percent occur often over periods of about ten minutes, and peaks of 25-30 percent occur occasionally. The control problem is to make the Shannopin feed follow these variations—which it did, as shown by the bottom chart section that recorded the secondary feed at the same time as the primary feed.

The system was started with control on automatic at the right side of the charts (time increases from right to left in this illustration), and the Shannopin flow rate came up to 600 tph without overshooting. The large peak on the left of the primary record was paralleled on the Shannopin record, after which a brief shut-down took place, and the system restarted —all while still on automatic.

Peaks and valleys in the Vesta record are closely followed by the Shannopin record. Occasional peaks in the Shannopin flow occurred when a new feeder was turned on.

OTHER BENEFITS

Advantages of the Trans-Weigh system include not only the solution to the original problem of providing a uniform high quality mixture, but also definite secondary features. The system is completely automatic so that operators do not have to switch to manual control when stopping or starting the conveyors. Location of the additional Vesta flow recording and integrating instrument in the superintendent's office permits simplified supervision of the system.

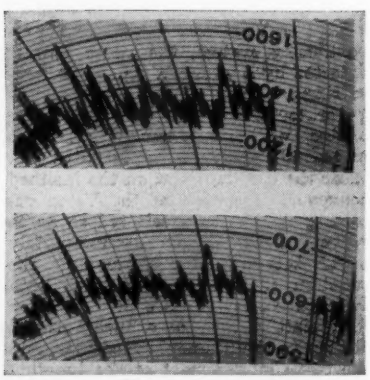


Fig. 4. Charts show simultaneous record of Vesta and Shannopin coal flow

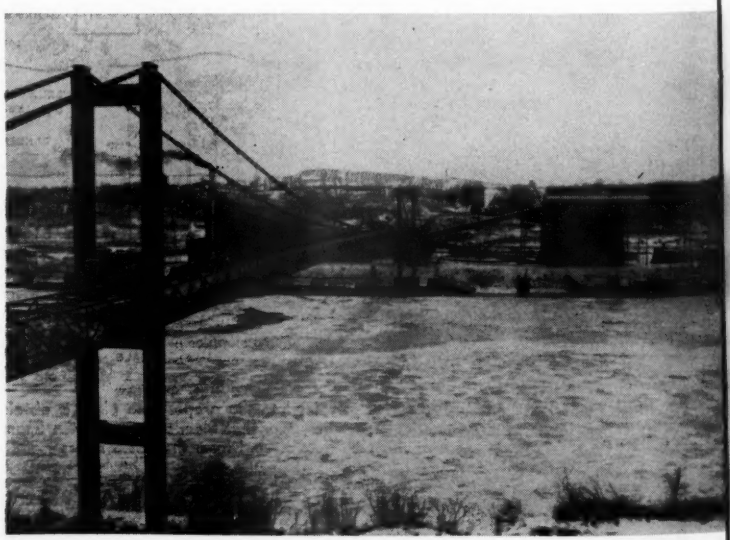


Fig. 5. View of Jones & Laughlin coal preparation plant, East Fredericktown, Pa., from Vesta mine end of bridge

wheels of government

As Viewed by HARRY L. MOFFETT of the American Mining Congress

THE legislative tempo of Congress is settling into high gear as leaders put on a drive to act on major pending measures quickly and open the door to adjournment some time in August. A number of appropriations bills, a revamped farm program, defense reorganization, atomic energy programs, and a host of other measures deemed of importance in an election year still remain to be considered by the Congress.

The House Ways and Means Committee continues hearings on proposals to increase Social Security benefit payments and to hike taxes to pay for them. Most observers are of the opinion that Congress will not act on a Social Security bill this year despite its political appeal.

Efforts to enact a minerals stabilization program are being stepped up in the Senate, where the Interior Committee, after lengthy hearings, has approved a bill to provide financial payments, purchase programs, and stockpiling for metals and minerals now in serious straits.

SENATE CONSIDERS TRADE ACT

Congressional action on the Administration-pushed bill to extend the Trade Agreement Act for five years passed the half-way mark when the House overwhelmingly approved it June 11 by a vote of 317 to 98 and sent it to the Senate.

The Senate Finance Committee began two weeks of hearings June 20. Committee Chairman Byrd (Dem., Va.) announced that testimony would generally be limited to the House bill, H. R. 12591, thus virtually excluding views on individual commodity problems. Industry witnesses, including a number representing mining, will testify in late June and early July.

Prior to enacting the bill, the House refused to accept, 234 to 147, a substitute bill by Rep. Simpson (Rep., Pa.) which would have afforded much greater protection for domestic industries and workers suffering from excessive imports.

Senate proponents of greater safeguards for domestic industries are expected to wage a determined fight to amend the bill, both in Committee and when it reaches the Senate floor this month. Meanwhile, strong sentiment is developing in the upper chamber to limit the Trade Agreements Act extension to three years.

OIL IMPORT RESTRICTIONS BROADENED

President Eisenhower has placed "unfinished" petroleum imports under the voluntary import restriction program, in an attempt to reduce opposition to the extension of the Trade Agreements Act. In the past only crude petroleum has been restricted, leaving a loophole for unlimited imports of topped crude oil suitable for further refining in this country.

The President's action, however, still leaves residual oil and gasoline without any import restriction, and the coal industry and domestic oil producers are trying to get some legislative protection through Senate amendments to the bill extending the Trade Act.

SEATON PLAN GETS FURTHER STUDY

In the wind-up of Senate Interior Committee hearings on the Administration's proposed Minerals Stabilization Plan, Interior Secretary Fred Seaton presented on June 19 a new proposal on copper and a supplementary program for lead and zinc. He also submitted a draft of legislation to implement the plan, and this was introduced the following day as S. 4036 by Senator Murray (Dem., Mont.) and nine other Western Senators.

The Committee began considering the bill immediately in executive session, and it was expected that a revised version would be approved shortly and placed on the Senate calendar.

Under the original Seaton plan, copper producers would have received stabilization payments which would return to them an amount equal to that which they would receive if the market price were 27.5 cents a pound, not to exceed one million tons annually.

The new copper proposal would not involve the payment of subsidies as proposed earlier, but instead would establish a purchase program under which the Government would acquire as soon as possible up to 150,000 tons of refined copper at the market price, but not to exceed 27.5 cents per pound—thus reducing commercial inventories currently overhanging the market.

In addition to the subsidy payments earlier proposed for lead and zinc, at stabilization prices of 14.75 cents and 12.75 cents per pound respectively, Seaton proposed that further payments be made to each producer to increase his total realization upon the first 500 tons of lead sold in each quarter to an amount which he would receive if the market price were 17

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Washington Highlights

CONGRESS: Legislative tempo increased.

TRADE ACT: Extension voted by House.

OIL IMPORTS: Restrictions broadened.

MINERALS PROGRAM: Before Senate Committee.

LABOR BILL: Hung up in House.

TAXES: Transportation taxes lifted by Senate.

DEFENSE PRODUCTION: Act extended two years.

ANTITRUST: Revisions active in Senate Committee.

COAL LEASING: Amendments before House.

STOCKPILING: New policies announced.

WALSH-HEALEY ACT: Coal wage minimums boosted.

DMEA: Extension bill before Senate.

ASSESSMENT WORK BILLS: House hearings held.

L-208 CASE: Supreme Court upholds Government.

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cents per pound, with similar payments to each zinc producer based upon the amount which he would receive if the market price were 14.5 cents per pound. Maximum payments under this provision would be 1.6875 cents per pound for lead and 0.9625 cents per pound for zinc.

Seaton made no changes in his earlier program covering fluorspar and tungsten, but suggested revised programs for the payment of production bonuses on limited quantities of beryl, chromite and columbium-tantalum. He also testified that antimony, cobalt and mercury do not qualify at this time for inclusion in the stabilization program.

The Senate Committee is expected to consider boosting the stabilization payments for lead and zinc and the setting up of borrowing authority for the Interior Department to conduct the program, thus avoiding the necessity of seeking annual Congressional appropriations.

Meanwhile, President Eisenhower announced that he was suspending his consideration of the Tariff Commission's recommended increases in duties on lead and zinc pending the outcome of Congressional action on the Seaton plan.

LABOR BILL PASSES SENATE

The Senate has passed and sent to the House a mild labor reform bill, endorsed by organized labor, but considered far from satisfactory by business generally. Dealing primarily with union internal affairs, it fails to meet the problems of secondary boycotts, union political activity, organizational picketing or other abuses revealed by the Senate Labor Rackets Committee.

Several attempts were made to put some teeth into the bill on the Senate floor, but all such moves were defeated. These included provisions dealing with organizational picketing, membership supervision of elections of union officials, secondary boycotts, a requirement for pre-strike ballots, union political activity, secret votes on "no strike" clauses in contracts, and others.

Many observers doubt that the House Committee will take action on a labor bill this year since Chairman Graham Barden (Dem., N. C.) is opposed to a weak bill of the type passed by the Senate and may keep it bottled up in his Committee.

SENATE VOTES TAX REPEAL

In a surprise move, the Senate voted to repeal the 3 percent tax on freight and the 10 percent tax on passengers. The repeal was contained in amendments to a bill to extend the present 52 percent corporate tax rate and certain excise taxes until June 30, 1959.

Since the bill extending the corporate and excise taxes has already passed the House, the Senate passed version of the bill must go to conference with the House. The House leadership has indicated opposition to the repeal and a compromise is possible.

DEFENSE ACT PASSES

A two-year extension of the Defense Production Act has been approved by both Houses of Congress and is now awaiting Presidential signature.

The bill extends authorities for priorities and allocations for defense and AEC contractors, loan guarantees and other aids for expansion of productive capacity and supply, exemption from antitrust laws for certain voluntary agreements, and the Executive Reserve program.

In testifying on the measure, Gordon Gray, director of the Office of Defense Mobilization, warned that ODM's borrowing authority of $2.1 billion is nearly exhausted and that additional borrowing authority is needed so that the Government may continue to fulfill its obligations for the purchase of metals and minerals under expansion contracts. He said the global shift in the metals market, from a short-supply to an over-supply situation, has affected the calculation of net cost to the Government by increasing calls on the Government to take metal at the option of the contractors and by making it impossible to place the accumulated metals inventories on the market.

Although the increased borrowing authority is not contained in the bill, Gray told Congress "the matter is under urgent consideration in the Executive Branch, however, and a recommendation will be submitted in the near future."

ANTITRUST BILLS ACTIVE

The Senate Judiciary Committee and its Subcommittee on Antitrust and Monopoly have been active in consideration of two bills which would amend the antitrust laws in such a manner as to hinder normal business activities. Both bills have been opposed by the American Mining Congress.

The full Committee recently reported a price discrimination bill but limited its application to food, drug and cosmetic items. As introduced, the bill would have been applicable to all business and industry, and would have nullified the good faith defense in price discrimination cases and made a riddle of the legality of freight absorption. Senator Kefauver (Dem., Tenn.), chief sponsor of the bill, has stated that he will seek restoration of its original language when it reaches the Senate floor.

The Antitrust Subcommittee is considering a bill which would require notification to the Attorney General and the Federal Trade Commission of proposed mergers and acquisitions by companies with combined assets of $10,000,000 or more. Although the bill provides few exemptions, its authors reportedly are willing to accept the exemptions included in a House version of the bill, one of which covered undeveloped and partially developed mineral, mining or timberland properties as proposed by the American Mining Congress.

COMMITTEE ACTS ON COAL LEASING

The House Interior Committee has approved an amended version of a Senate-passed bill (S. 2069) which would double, from 5,120 acres to 10,240 acres, the maximum amount of public lands in any one State which a company or individual could hold under coal leases, and the House is expected to act on the measure prior to adjournment.

The bill would also permit the leasing of an additional 5,120 acres if the Secretary of the Interior found that more land is needed by the applicant "in order to carry on business economically and is in the public interest."

Deleted by the Committee was a Senate provision which would free railroads from the special restrictions placed by the Mineral Leasing Act of 1920 on their use and sale of coal from leased public lands. A separate bill (H. R. 12805) to accomplish this purpose was introduced later by Rep. Walter Rogers (Dem., Tex.), chairman of the House Interior Subcommittee on Mines and Mining; no action has been taken on it.

STOCKPILING POLICIES REVISED

Both the Office of Defense Mobilization and the Senate Appropriations Committee have determined that materials in the national stockpile should be upgraded where feasible so that they will be available for immediate use in an emergency, and the Senate Committee added $10.5 million to an appropriations bill to initiate such a program if the House concurs.

At the same time, ODM announced other changes in policies governing the stockpiling of strategic and critical materials. These changes provide that (1) materials will be stockpiled for a three-year emergency period, instead of five years; (2) close observation will be maintained on the use of materials having high temperature or other special properties in order to keep abreast of changing technology; (3) contracts for materials in excess of maximum objectives will be canceled when this can be accomplished by mutual consent of suppliers and the Government; and (4) upgrading of subspecification materials may be undertaken only when this can be accomplished at less cost to the Government than the purchase of new specification-grade materials.

COAL WAGE RATES

Secretary of Labor Mitchell has proposed a 50-cents-an-hour increase in the minimum wage rates for miners of bituminous coal falling within the jurisdiction of the Walsh-Healey Act, which applies to all concerns that sell more than $10,000 worth of products to the Federal Government. This increase would put the minimum wage rate at $2.745 per hour in coal Districts 1, 2, 3, 4, 6, 7, 8, and 10. No wage proposal was made for District 5, and $2.59 per hour was proposed for Districts 9, 14 and 15. Rates of $2.796 were proposed for Districts 16, 17 and 18 and $2.82 for Districts 19 and 20. Other hourly wage rates proposed were as follows: District 11, $2.78; District 12, $1.40; District 13, $2.515; District 21, $2.226; District 22, $2.846, and District 23, $2.735. Previous minimum rates would be applicable to South Dakota, North Dakota and Iowa.

DMEA BILL ADVANCES

An Administration-backed measure to make permanent the minerals exploration program (DMEA) has been approved by the Senate Interior Committee and is now awaiting Senate action.

The bill (S. 3817) would somewhat revise the DMEA program of financial aid for mineral exploration by limiting Government participation to not more than $250,000 per contract; requiring that interest be paid at average Treasury rates plus two percent for administrative costs, and requiring the applicant to show that exploration funds are unavailable from private sources on reasonable terms.

ASSESSMENT WORK BILLS CONSIDERED

The House Mines and Mining Subcommittee has held hearings on bills which would change the date for completing annual assessment work on mining claims from July 1 to September 1, and permit the crediting of geological, geochemical and geophysical work towards the annual labor requirement on unpatented mining claims.

Julian D. Conover, executive vice president of the American Mining Congress told the Subcommittee that the industry had no objection to changing the dates for performance of assessment work, but cautioned that any bill validating geophysical, geochemical and geological work must be very carefully worded to avoid any possibility of fraud. A spokesman for the Department of Interior agreed with the Mining Congress statement.

No action has been taken on either bill.

GOLD MINERS LOSE L-208 CASE

Gold mine owners required by the Government to shut down operations during World War II lost their last chance to be compensated for the losses they suffered when the U. S. Supreme Court recently reversed, 7 to 2, a 1956 Court of Claims decision that six companies were entitled to compensation.

The case stemmed from War Production Board Order L-208, issued in 1942, which required closing of gold mines deemed nonessential to the war effort, with the object of conserving scarce equipment and materials and encouraging the voluntary relocation of skilled miners to the more vital copper mining industry.

In appealing for reversal of the Court of Claims decision, the Justice Department said that similar claims could boost the Government's total liability to more than $40 million. The Supreme Court majority opinion said that the "damage to the mine owners was incidental to the Government's lawful regulation of matters reasonably deemed essential to the war effort."

personals

Frank R. Milliken and **Carl K. Lenz** were elected to the board of directors of Kennecott Copper Corp. May 20, following stockholder approval of an amendment of the corporation's charter and by-laws permitting an increase in the number of directors from 15 to 17. Milliken is executive vice president of Kennecott, and Lenz is president of its sales subsidiary, Kennecott Sales Corp.

F. R. Milliken

Meanwhile, the huge copper producer's Utah Copper Div. announced that **Frederick C. Green,** assistant general manager of the division, has succeeded **L. Fern Pett** as general manager. Pett retired April 30. Green in turn, has been succeeded as assistant general manager by **I. K. Hearn, Jr.,** formerly chief industrial engineer of Kennecott's Western Mining Divisions.

C. K. Lenz

L. F. Pett

Green joined Kennecott in 1917 at the Ray Mines Division, Hayden, Ariz. In 1924 he joined Utah Copper Division as a flotation operator, rising to general mill foreman and assistant superintendent. In 1939 he became mill superintendent for Chino Mines Division and in 1946 was named general superintendent of the reduction plant. He left Chino Mines Division as assistant general manager in 1953 to join Utah Copper Division as assistant general manager.

F. C. Green

I. K. Hearn

Hearn had his early mining experience with the Tennessee Coal and Iron Division of United States Steel Corp. He left there as chief operations engineer for TCI's ore mines and quarries in 1949 when he was named assistant to the president of Quebec Iron and Titanium Corp., a joint Kennecott-New Jersey Zinc subsidiary. Later he was named assistant to the president of Kennecott Copper until his appointment as chief industrial engineer of the company's western mining divisions.

John S. Routh, Jr. has been named executive vice president and a director of the Pittston Co., succeeding the late **Andrew Denari.** Routh was formerly executive vice president of the Pittston Clinchfield Coal Sales Co., a subsidiary.

Joseph T. Berta was elected senior vice president and a director of the parent company. He continues as president of Pittston Clinchfield.

Walter A. Sterling has been elected chairman of the board and president of the Cleveland Cliffs Iron Co. He succeeds **Alexander C. Brown** as chairman. Brown is retiring after nearly 24 years of outstanding service; first as senior vice president, then president in 1947, and finally chairman of the board in 1953. Both Sterling and Brown continue as Cliffs' directors. Sterling has been president since 1953 and chief executive officer since 1955.

A. C. Brown

W. A. Sterling

It was also announced that **W. E. Dohnal,** formerly assistant treasurer in charge of budgeting, systems and procedures, was elected comptroller, and **D. E. Sadler** appointed special assistant-finance.

The board of directors of International Minerals & Chemical Corp. have elected **Thomas M. Ware** president.

At 39, the former administrative vice president becomes the fifth and youngest president of the 50-year-old corporation which is the world's largest producer of phosphate and a leader in the mining and processing of potash, feldspar and other industrial minerals. He succeeds his father, **Louis Ware,** who was elected chairman of the board and chief executive officer.

Louis Ware

Thomas Ware

T. M. Ware joined IMC in 1947 as industrial engineer and in the next five years, a period of major company expansion, directed construction of new plant facilities and installations as chief engineer. Elected vice president of engineering, he planned, coordinated and directed a program that streamlined methods in IMC's 72 mines and plants throughout the country. In 1955 he was named administrative vice president. He was elected to the board of directors in 1957 and has had the additional responsibilities of the executive vice president since the retirement of James P. Margeson last year.

Liberty Fuel Co. president **Walker Kennedy** has assumed the presidency of the Utah-Wyoming Coal Operators Association. He succeeds **W. J. O'Connor.** The new vice president is **G. E. Sorensen,** president, Kemmerer Coal Co. **W. W. Clyde,** president, Knight Ideal Coal Co., was elected to the board. Other directors and officers were re-elected.

R. E. Schneider

The Anaconda Co. recently announced the election of **Ralph E. Schneider** as secretary and treasurer. He succeeds **C. Earle Moran,** retired.

Schneider commenced his association with Anaconda in 1928 as an accountant. He has been assistant secretary and assistant treasurer of Anaconda and several of its subsidiaries since 1947.

John J. Sanford recently retired as senior field engineer for the Bunker Hill Co. after 48 years of service with the company.

A. Vernon Sproles has been elected president of Pocahontas Fuel Co., Division of Consolidation Coal Co.

Sproles has been associated with Pocahontas and its predecessor companies for 50 years, having started in 1909 as a member of the engineering corps in one of the company mines. In a series of promotions he became safety director, assistant general superintendent, and later general superintendent. In 1953 he was elected vice president in charge of operations.

Donald C. Tretzel and **D. G. Farquharson** have been elected vice presidents of Kaiser Bauxite Co., wholly owned subsidiary of Kaiser Aluminum & Chemical Corp., operating bauxite mining, processing and shipping facilities on Jamaica, B. W. I.

Tretzel, who is works manager of the company, and Farquharson, who is the company's administrative manager, have been associated with the development of Jamaican bauxite operations since 1951, when Kaiser began building facilities in the Spur Tree and Port Kaiser area on the island's south coast.

Sidney C. Howell, chief mining and industrial engineer for Republic Steel Corporation's northern ore mining district, has been appointed manager of the district. He succeeds **F. H. Cash,** who retired April 15 after more than 49 years of service.

Howell joined Republic in 1940 as a mining engineer at the Cambria mine. In 1943 he was transferred to Hibbing, Minn., as pit foreman at the company's Susquehanna mine. A year later he became industrial engineer of the northern mining district and in 1955 was given the additional responsibilities of district chief mining engineer.

The board of directors of American Potash & Chemical Corp. on May 2 increased the number of directors from nine to ten and elected **Charles R. Lindsay, III,** a director and vice president of the company. Lindsay is president of Lindsay Chemical Division of American Potash.

The merger of Lindsay Chemical Co. into American Potash & Chemical Corp. became effective on May 1.

Cecil Delloma has been appointed superintendent of Hanna Coal Company's Georgetown No. 12 mine. Delloma has been an employe at the Georgetown mine for the past 17 years.

Anthony Lane was recently appointed manager of Yucca Mining Corp. and Florida Manganese, Inc.

After being in charge of the health and safety activities for the Salt Lake offices of the U. S. Bureau of Mines since 1942, **Robert D. Reeder** is being transferred to Washington, D. C. He will be in charge of the activities of the Joseph A. Holmes Association.

A. C. Borgeson retired as chief mining engineer of the Shenango Furnace Co. and Snyder Mining Co. in May after 47 years with the two iron mining companies.

George A. Strunck has been named vice president in charge of production for Old Ben Coal Corp. He succeeds **Howard Lewis,** who retired June 30. Lewis is a brother of UMWA president John L. Lewis.

At the time of his promotion, Strunck was superintendent of surface plants for Old Ben.

T. L. Johnson

French Workman has retired as general manager of mines for The Lorado Coal Mining Co. at Lorado, W. Va. after more than 41 years of service. **Timothy L. Johnson** has assumed the responsibilities of operating assistant to the president and will have charge of the Lorado operation. **John W. Straton,** recently appointed general superintendent, will be directly responsible for the supervision of the various departments at Lorado.

John Owens, formerly Cuyuna range geologist for the M. A. Hanna Co. at Crosby, Minn., is now geologist for Ozark Ore Co. at Ironton, Mo.

— *Obituaries* —

Andrew F. Denari, 52, president of the Pittston Co., died of a heart attack May 2.

Mr. Denari began his career in the coal business as a junior clerk with the Pennsylvania Coal Co. in its New York office. In 1930, when the Pittston Co. was organized as the successor of the Pennsylvania Coal Co., Mr. Denari was on the staff of the company president. In 1936 he was made assistant secretary. He became assistant treasurer in 1938, secretary in 1939 and in 1943 became vice president as well as secretary.

Three years ago Mr. Denari was named executive vice president and a director of Pittston. His election to the presidency came in 1956. He was also an officer and director of various other coal companies, all of them Pittston affiliates and subsidiaries. They included the Sheridan-Wyoming Coal Co., Globe Fuel Products, Inc., the Pittston Clinchfield Coal Sales Corp., the Lillybrook Coal Co., and the Davis-Clinchfield Export Coal Co.

H. W. Bauer, 55, former general manager of the West Virginia Coal and Coke Co. at Omar, W. Va., died May 22.

E. N. Norris, about 77, former official of the Anaconda Co., died May 7 at Chula Vista, Calif., where he had moved after his retirement from Anaconda. Mr. Norris played a leading role as general manager in developing the Conda, Idaho, phosphate properties 30 years ago. At the time of his death he was employed as a consulting engineer with Victor Chemical Co., operators of an elemental phosphorus plant at Silver Bow, Mont.

Kenneth Tillery Price, 55, vice president in charge of the Louisiana producing operations of Freeport Sulphur Co., died suddenly of a heart attack May 11.

Mr. Price joined Freeport Sulphur as an engineer in 1925 at the company's Hoskins Mound plant near Freeport, Texas. He became superintendent of scouting at Freeport in 1930 and was transferred to Louisiana as superintendent of production at Freeport's first Louisiana mine in 1934. In 1942 he was named superintendent of that property and in 1951 became assistant vice president. He was elected vice president in 1952.

Allen B. Williams, retired Aluminum Co. of America executive, died May 16 in Pittsburgh.

Mr. Williams became vice president of Aluminum Ore Co. in 1942 and was president of that company from 1946 until the subsidiary was made an operating division of Alcoa. In 1955 he retired as general manager of Alcoa's refining division.

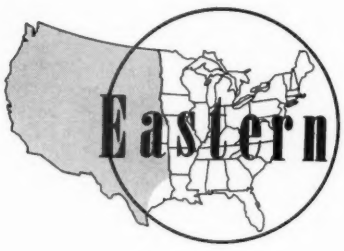
William B. Poindexter, a vice president of the M. A. Hanna Co., died May 26 in Cleveland, Ohio.

For the last 12 years Mr. Poindexter had been vice president in charge of the lake coal division. His association with Hanna began in the 1920's.

Claire Stewart Lynch, 53, president of the Mecca Mining Co., died May 9 in Salt Lake City.

John Joseph Inman, 64, district manager of the American Lead and Zinc Co. at Webb City, Mo., died May 10. He had been connected with American Lead and Zinc for 43 years.

NEWS and views



Stoker Coke Made as a By Product

What is believed to be the first carload shipment of stoker coke produced by a method referred to as a continuous process in conjunction with steam generation was recently announced by Island Creek Coal Co. Three carloads of the new product were produced on a test basis in cooperation with the P & L E Railroad at its plant in McKees Rocks, Pa., and shipped to a chemical plant for use in producing calcium carbide.

This initial shipment is the culmination of more than two years of laboratory research on the production of stoker coke from Island Creek's Scarlet Flame low-ash coking coal.

In this process, coking coal is continuouously fed to a traveling-grate stoker operated at approximately double its normal speed. By control of air admission, the volatile matter in the coal is burned to provide heat for coking and to raise steam, while most of the fixed carbon in the coal is recovered in the form of small-sized, porous, high-temperature coke. When exceptionally low-ash coal is used, the resultant coke is well suited for electro-chemical and electro-metallurgical processes such as the manufacture of calcium carbide, phosphorous, and ferro-alloys.

The basic process is already in commercial use in Canada and South Africa, but in these countries the heat produced is used to burn lime, while in the Island Creek application of the process it is used to produce steam.

There is a growing shortage of small-size coke. The possiblity of producing this type of coke continuously in combination with the generation of steam and power promises a means of relieving this shortage and meeting the growing demands of the chemical industry. Island Creek plans to expand its activities in this field.

Kaiser Aluminum Plant in Operation

After four years of effort and the expenditure of more than $200,000,000 by Kaiser Aluminum & Chemical Corp., the fully integrated production of aluminum has begun in the Ohio Valley. It is the company's first bid for the eastern aluminum market. Two of the four potlines of the Ravenswood, W. Va., reduction plant are now in operation, with an annual capacity of 72,500 tons of primary aluminum.

11 Men Win Holmes Medals of Honor

Medals of Honor have been awarded 11 men in the Nation's mineral industries by the Joseph A. Holmes Safety Association for heroic action in saving the lives of other persons, according to Marling J. Ankeny, director of the Bureau of Mines and Association president. In addition, the Association voted two group citations to a total of 20 men, and awarded 505 Certificates of Honor for outstanding safety records and outstanding success in safe supervision.

Winners of the individual Medals of Honor were: Gerald W. Flowers, San Leon, Tex.; Max G. Broadhead, Provo, Utah; Leslie T. Tracey, Gouverneur, N. Y.; Frank C. Mauney, Norphlet, Ark.; Russell L. Funk, Henderson, Tex.; Woodrow Evans, Amonate, Va.; Luther E. Allen, Haysi, Va.; Alex Dutko, Marianna, Pa.; Frederick W. Pfau, Dearborn, Mich.; Nelson G. Fry, Melvindale, Mich.; and Hughie Wayne King, Benham, Ky.

One group award went to 13 workers at the No. 31 mine of the Pocohontas Fuel Co., Inc., McDowell County, W. Va., for their cooperative work in finding a place of safety and building barricades following an explosion. The other group award went to seven men who participated in a rescue at the No. 1 mine, Bobs Branch Coal Co., Haysi, Va.

Ankeny also announced adoption of new and stiffer standards under which individuals, mines, and mineral-processing plants can qualify for safety awards of the Joseph A. Holmes Safety Association. The new award requirements reflecting improved safety conditions in the mineral industries, were adopted at the Association's annual meeting, held recently in Washington, D. C. They were proposed by the Association's awards committee following a comprehensive review of recent injury and fatality experience in the various eligible industries.

Texas Gulf Facility Begins Production

Officials of Texas Gulf Sulphur Co. recently opened the valves at the company's Fannett Dome plant near Beaumont, Texas. The multimillion dollar operation is designed to produce 500,000 tons of sulphur annually. Served by eight wells, it is a Frasch process facility.

Most of the sulphur will be shipped to customers in a molten state from special facilities recently put into operation near the firm's Spindletop plant. The company recently began shipping molten sulphur in specially built barges to customers in St. Louis.

Union Electric Sells Illinois Coal Mine

Union Electric Co. recently announced the sale of its New Kathleen mine near Dowell, Ill., to Truax-Traer Coal Co. and United Electric Coal Companies, both of Chicago. Truax-Traer will take over the equipment and buildings and United Electric will acquire the adjacent coal reserve.

Union Colliery Co., Union Electric subsidiary which owned and operated the New Kathleen mine, will continue in existence. The subsidiary holds coal property near Shawneetown, Ill., but there are no present plans to develop the reserves.

Union Electric is going out of the coal business because there is an ample supply available to it at reasonable prices. The firm will concentrate its efforts and capital in the utility business.

Ohio Lime Plant Closed

Basic, Inc., closed its lime plant at Clay Center, Ohio in June. Building-lime products formerly made at Basic's White Rock plant (Clay Center) will now be produced at Gibsonburg, Ohio, under the improved manufacturing methods afforded by new facilities.

The rotary kilns at the White Rock plant will be maintained as surplus dead-burned dolomite facilities to meet any requirements beyond the capacities of Basic's 11 other kilns in Ohio.

Improved facilities at the Gibsonburg plant are expected to be completed soon at a cost of $400,000.

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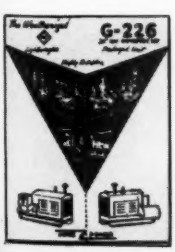

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BG-27

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Bureau to Test European Machine

A continuous mining machine, used successfully in mining semihard coal in Europe, is being imported by the Bureau of Mines for testing on Pennsylvania anthracite. The Bureau hopes to have the device, called an Anderton-type drum-cutter-loader, operating experimentally in an anthracite mine near Wilkes-Barre, Pa., by midsummer.

A revolving drum studded with steel teeth is the key feature of the drum-cutter-loader, according to Bureau mining engineers who saw it work in Europe last year. In operating it, the drum is started in an opening at one end of a long wall of coal. Then, as the machine travels parallel to the coal face on an armored chain conveyor, the drum moves at right angles to the face. The teeth of the drum chew out coal to a depth of two or more feet into the face and a height of 30 in. Hydraulic jacks hold the machine and conveyor against the coal face as it travels.

The machine's cutting action is expected to throw much of the coal onto the conveyor which carries it off. Any that falls short will be pushed onto the conveyor by a plow-like scoop, also part of the device, that goes to work when the machine is returned for a second cut.

Coal above the bottom cut is expected to fall of its own weight. However, Bureau engineers say it may be necessary to drill this coal to hasten falling.

The drum-cutter-loader is one of three machines the Bureau will use in a full-production-scale longwall mining experiment to be conducted in cooperation with the Glen Alden Corp. The other two devices are a plow, which will be used to load loose coal onto a conveyor after the longwall has been undercut and blasted, and a coal planer that is similar in operation to the drum-cutter-loader except that it employs pneumatically powered steel blades to chisel coal from the face. Preparations for the experiment have begun at the company's Wanamie mine about ten miles southwest of Wilkes-Barre.

U. S. Steel, Linde Announce Plans for Oxygen Plant

Linde Co., Division of Union Carbide Corp., and the U. S. Steel Corp. have jointly announced plans for a 1000 tpd oxygen plant and pipeline system. It will serve four of U. S. Steel's plants on the Monongahela River, south of Pittsburgh, Homstead; Edgar Thomson; Duquesne; and the National Works, National Tube Division. The plant will be located at the Duquesne Works and will distribute oxygen to the other three by pipeline. Provision is made for future extension of the pipeline to a fifth location, Carrie Furnaces.

U. S. Steel Unit Plans to Develop Quebec Iron Ore Deposits

L. J. Severson, president, Quebec Cartier Mining Co., a subsidiary of U. S. Steel, recently announced that the company has invited bids to build a 193-mile railroad alongside the access road from Port Cartier to Lac Jeannine, Quebec, and also to construct a 60,000-hp hydroelectric plant on the Hart-Juane River, a tributary of the Manicouagan River, a few miles south of the company's main mining area.

The 200-mile access road which was started in mid-1957 has now been completed along with the construction of an air strip to serve the area.

It is anticipated that bids for other portions of the project will be invited when engineering design has been completed. These will include the construction of a new deep-draft harbor and loading facilities at Port Cartier, near Shelter Bay, and the preparation of a large open pit mine and concentrator for the production of high-grade iron ore concentrates.

H. I. Young Receives Honorary Degree

Howard I. Young, president of American Zinc, Lead & Smelting Co., was awarded an honorary doctorate by Rensselaer Polytechnic Institute at its 152nd commencement.

The 27 years in which Howard I. Young has been president of the American Zinc, Lead & Smelting Co.

have seen the assets of that internationaly known firm advance from $3,000,000 to $37,000,000 and annual sales from $1,800,000 to $76,800,000 in 1956. For 25 years he has been president of the American Mining Congress, is a director of numerous large corporations and has served as chairman or president of major civic organizations in St. Louis where he resides. At the age of 18 he became a bookkeeper for the company he now heads, a mine manager at 21 and at 29 was manager of the company's entire mining operations.

New Ontario Plant Produces Uranium Metal

Canada's new uranium metal plant at Port Hope, Ontario, has started operations, marking the completion of a long-range program to make that country self-sustaining in the field of atomic energy. Eldorado Mining & Refining Ltd., a Crown company which operates the plant, said the facility will manufacture uranium for domestic consumption and export.

The first ingot of uranium cast by the plant is believed to be the largest single piece of uranium metal ever produced by a process in which it is mixed with magnesium.

Uranium metal produced at Port Hope will be turned over to AMF Atomics (Canada) Ltd. of Port Hope, Canadian subsidiary of American Machine & Foundry organization. This company has a contract with Atomic Energy of Canada for production of uranium fuel rods. AMF Atomics will supply fuel rods to Atomic Energy of Canada at cost; however, the company will make a profit on the manufacture of rods for use by other purchasers in Canada and sold on the export market.

Alabama to Get New Coal Mine

Southern Electric Generating Co., now building a $150,000,000 steam plant at Wilsonville, Ala., has awarded a $500,000 contract to Cowin & Co., Inc., Birmingham mining engineers and contractors, covering initial steps for opening a new mine near Parrish in Walker County. The mine is expected to go into production in 1959 and furnish employment for 500 persons. Production will rise from 250,000 tons in 1959 to 1,500,000 in 1961. SEGC has acquired extensive coal reserves in both the Warrior and Cahaba coal fields of Alabama and plans the development of mines to supply substantially all of the steam plant's fuel requirements.

Zinc Workers Vote Voluntary Pay Cut

The executive comittee of the Oil, Chemical and Atomic Workers Union at the Monsanto plant of the American Zinc Co. recently averted a shutdown of that plant by recommending a cut of ten cents per hour in the production bonus now being received by its members.

One hundred twenty-five employes had already received notices of their dismissal and one-half of the production had been curtailed. The action of the union forestalled the curtailment of the balance of the production.

The growing stocks of zinc in the country and heavy imports of foreign special high-grade zinc are making it difficult for zinc producers to continue normal operations. By changing the quality of the zinc produced American Zinc hopes to be able to dispose of its current production and to keep the 350 employes of the plant at work.

ALSO . . .

The aluminum industry is "not dismayed" by the current business recession but regards it as "just a pause before another upward spiral in the use of our metal," Walter L. Rice, president of Reynolds Mining Corp., said in a recent address to the Six O'Clock Club in Minneapolis, Minn. He said a careful market study by his company shows that the aluminum industry's 1958 productive capacity will have to be doubled by 1965 and redoubled ten years later.

Jones & Laughlin Steel Corp. has announced record-breaking regular production of 81-ton heats of steel by the basic oxygen process. It is said to be the largest size heat being produced by any basic oxygen furnace in the world.

Texas Gulf Sulphur Co. and Freeport Sulphur Co. have disclosed the formation of a jointly owned subsidiary to market their product outside North America. The new company, Sulphur Export Corp., will manage exports and sales of all sulphur sold abroad by the two companies, which operate primarily in Texas.

A new bucket has been installed on the Mountaineer, Hanna Coal Company's giant shovel. The shovel can now move ten tons more per trip; making a total of 100 tons per pass at the eastern Ohio coal stripping operation.

Construction of a $1,000,000 plant for production of molybdenum metal and molybdenum-base alloys was announced by American Metal Climax, Inc., of New York. Situated at Coldwater, Mich., the plant will be owned and operated by Climax Molybdenum Co. of Michigan, a wholly-owned subsidiary of American Metal Climax.

From suggestions submitted by men throughout the mineral industry, the Program Committee has selected outstanding topics for all sessions at the forthcoming Metal Mining and Industrial Minerals Convention and Exposition, and has invited top-notch speakers to cover the important problems of the industry

Why Should YOU Go to San Francisco?

WHY should you attend the 1958 Metal Mining and Industrial Minerals Convention and Exposition of the American Mining Congress September 22-25 in San Francisco? Good question—and one to consider right now. If you'll read on for just a few minutes we'll try to answer it.

First of all, it's your Convention and Exposition. For example, the National Program Committee met June 18 in San Francisco under the chairmanship of Frank Coolbaugh and reviewed hundreds of suggestions sent in by mineral producers all over the country. The net result—an outstanding list of topics to fill sessions on national mineral policies; the outlook for the industry, labor and management; research and education; public lands; taxation; gold, silver and monetary policies; industrial minerals; strategic metals; uranium; exploration and geology; underground mining; open-pit mining; milling and metallurgy, and last, but certainly not least, safety and health.

Of course, a strong list of subjects designed to answer many of the questions confronting the industry today requires speakers thoroughly familiar with their subjects. There is no shortcoming in this regard. High-ranking Government administrators, Senators and Representatives, and experienced mining men have accepted invitations to participate in the convention program.

The Exposition of mining and processing machinery, equipment, and supplies is the largest ever held. It presents an invaluable opportunity to inspect all the new developments for more efficient and lower-cost operation and to discuss your own particular problems with the experienced manufacturers' representatives who will be on hand for that purpose.

Now, a second good reason you should attend. The Convention and Exposition is arranged for your pleasure as well as your education. Every mining man and lady is invited to attend the social functions. One of the major events is the Miners Jamboree scheduled for Tuesday night, September 25, at the historic Palace of Fine Arts. A real Western-style dinner with an abundance of music, dancing and entertainment, it is an event that is enthusiastically attended year after year. Then, the climaxing event of the 1958 Mining Show will be a truly speechless dinner dance held in the world-famous atmosphere of the Garden Court at the Sheraton-Palace Hotel. At this event, another fine floor show will follow the dinner.

For ladies only—on Monday afternoon: a reception and tea at the Alta Mira Hotel in Sausalito, with a breath-taking view of San Francisco Bay, and a "look-see" at Chinatown, Coit Tower, Fisherman's Wharf, and Mariana, the Presidio and the famous Golden Gate Bridge en route. Tuesday: a scenic drive through the East Bay country and luncheon at Castlewood Country Club at Pleasanton, in the rolling hills of California's wine country. Wednesday: a delicious luncheon in the Venetian, Gold and Nob Hill Rooms of the stately Fairmont Hotel, following which Saks Fifth Avenue will present a special fashion show of Fall and Winter styles.

Special trips are on the agenda for Friday and include visits to a cement plant, auto assembly plant, one of the largest research institutes, a magazine publishing facility, and one of the most fabulous estates in the Americas. The exciting Salmon Derby will also be held on Friday, and amateurs and experienced fishermen alike will have ample opportunity to hook some of the big ones. (By the way, there are special prizes for the biggest catch.)

Getting back to the Convention and Exposition for a minute, remember that the comprehensive array of exhibits, coupled with the outstanding convention sessions, amount to an advanced course in how to mine and process the mineral resources of our country. Mining companies generally recognize this and send every key operating man that can possibly be spared.

Full descriptions of the Exposition will appear in the August issue of *Mining Congress Journal*. Complete details on trip and entertainment functions have already been mailed throughout the mining and quarrying industries. If you haven't already done so, order your tickets promptly to make sure you won't miss these events. Forms are available from American Mining Congress, 1102 Ring Bldg., Washington 6, D. C.

Most important of all—right now San Francisco hotels are receiving hundreds of reservations for the week of September 21. Assure your accommodations by sending your hotel reservation request immediately to the American Mining Congress Housing Bureau, San Francisco Convention and Visitors Bureau, Room 300, 61 Grove St., San Francisco 2, Calif.

NEWS and views

Coeur D'Alene Celebrates Silver Jubilee

The Silver Capital of the U. S. A., Wallace, Idaho, staged a four-day party June 11-15 to which the whole country was invited. The occasion—Wallace's 75th birthday, the first National Silver Jubilee, and Wallace Silversmiths of Connecticut silver celebration. During the Silver Jubilee, which ran all the month of June, the whole town turned back the clock to the early mining days. Everyone dressed in old-time costumes, and historic locomotives with new coats of silver paint puffed along on ancient tracks. But the Silver Jubilee highlights were the silver, zinc and lead mines and special tours were conducted through the mines and smelters that surround Wallace and Kellogg. Wallace produces mill and mining equipment, is a lumber as well as a mining metropolis, and boasts America's only mine-sponsored ski school.

Multi-Million Dollar Expansion for Kennecott

Charles R. Cox, president of Kennecott Copper Corp. outlined his company's multi-million dollar expansion and modernization program in a recent report to stockholders.

In the past, Cox related, it was unnecessary and economically undesirable for Kennecott's predecessors to provide their own smelting and refining capacity. However, this situation was altered by the following: (1) the company's copper production increased beyond the capacity of the smelters; (2) a western movement of fabricating plants and a need for more electrolytic copper developed; (3) the economic benefit of eliminating smelting and refining fees increased; and (4) greater operational control over the entire sequence of copper production became increasingly important.

The company, therefore, decided to take one of the most important steps in its history—the integration of its copper producing facilities. Construction of the new smelter at Ray Mines Division is due to be completed this summer and construction of the new Eastern refinery in Maryland is scheduled for completion next year. With the completion of arrangements for the purchase of the Garfield Smelter of American Smelting and Refining Co., Kennecott will be doing all of its own smelting, and most of its own refining. When the present amended refining contract with Asarco expires in 1965, the company plans to construct necessary additional refining capacity to make it 100 percent integrated.

The entire integration program is estimated to cost $111,000,000. Of this amount $19,000,000 has been spent thus far and $57,000,000 is presently committed for expenditure during 1958 and 1959. The remaining estimated $35,000,000 is for modification of the Garfield Smelter in order to adapt it to the company's requirements and for later refinery expansion. Expenditures for these last two parts of the program will be spread over the 1959 to 1965 period.

Tracer Laboratory Planned for Salt Lake City

United States Bureau of Mines recently announced location of a radioisotope tracer laboratory at the Intermountain Experimental Station in Salt Lake City, Utah. A similar station is under construction at Reno, Nev. The stations are the first in the United States to conduct basic research on the use of radioactive tracer material in extractive metallurgy.

Among projects at the Salt Lake operation will be bench work using radioactive manganese, iron, nickel, cobalt and silver-tagged clays. Studies will include research into flotation, leaching and smelting of manganese ores; extraction and production of pure nickel and cobalt; segregation and recovery of copper from oxidized ores. After testing on bench basis, the tracer techniques will be tested in pilot plant mill operations at the Bureau's 900-sq ft laboratory. Elaborate safeguards are built into the new labs for protection of employes from any effects of radioactivity.

Utah Lead Smelter Forced to Shut Down

United States Smelting Refining & Mining Co. announced on June 16 in a letter to its employes that the firm had been forced to the decision to discontinue smelter operations at Midvale, Utah. Except for a few minor shutdowns, the smelter has operated continuously for over 55 years. Ever mounting costs, a decreasing amount of available smelting materials, low metal prices and the general outlook led to the decision.

Arrangements have been made under which ores, concentrates and other lead smelting products produced by the company from its own mines and plants in the Salt Lake area, as well as other products purchased by the company in the open market from others, will be smelted on toll by International Smelting & Refining Co. at its Tooele Smelter with the lead bullion and other resuting products being returned to U. S. Smelting for further refining and sale.

The Midvale flotation mill will continue to operate, treating lead-zinc concentrating ores produced by U. S. Smelting from its mines and such ores as the company purchases in the open market or on contract from others. In addition, it will treat milling ores in toll for International, the resulting concentrates therefrom being returned to International.

U. S. Smelting also announced that it will continue to purchase lead smelting ores, lead and zinc concentrates and other smelting products in the open market as in the past, as well as lead-zinc concentrating ores for its mill.

West Virginia Firm Plans Alaska Project

The Jewel Ridge Coal Co. of West Virginia is planning an extensive exploration project in the Bering River Coal Field, which is about 50 miles east of Cordova, Alaska. If results are favorable, a large production of coal for shipment to Japan will result. Jewel Ridge is reportedly also looking into the Broad Pass coal on the Alaska Railroad.

Chino Sets Safety Record

Employes of two departments at the Chino Mines Division of Kennecott Copper Corp. at Hurley, N. Mex., have set a new safety mark.

The mill operations and reduction plant maintenance departments broke their old record of 247 days without a lost time accident and had worked 251 days without serious mishap on May 21. The previous record was set in 1951.

Monsanto Plans New Facilities

Monsanto Chemical Co. recently announced that work will start in the near future on a new private road between its elemental phosphorus plant at Soda Springs, Idaho, and its phosphate mine 11.2 miles away. The new road to be constructed by Morrison-Knudsen Co., which operates the mine for Monsanto, will enable use of specially constructed carrier units capable of hauling 75 tons of ore each trip. This is three times the haul load possible with present transportation operation, a Monsanto official said.

The carefully engineered route permits most of the distance from the mine to the plant to be either level or on a downhill grade for the loaded carriers. No grade in either direction will be more than three percent and no curve will be more than 10°. These conditions will permit a high degree of safety in hauling the large loads.

The road will enable far more efficient hauling of ore to the mine, as seven of the new carriers are expected to do the work of the 15 smaller trucks now used in the operation. The new facilities are scheduled to be in operation by the summer of 1959.

Horse Heaven Mine Shut Down

Mercury production at the Horse Heaven Mine of Cordero Mining Co. was terminated in May of this year. Located in central Oregon, this was one of the older, more efficient mercury operations in the west. Track, equipment and other salvageable materials are being removed from the property, thus making it extremely doubtful that the mine will ever be reopened.

Idaho Firm Plans New Silica Plant

Plans for a $300,000 plant at Lapwai, Idaho, for the production of silica sands was recently announced by Sunbeam White Sands, Inc. The Moscow firm, incorporated two years ago to do test work on furnishing filter sand for the Hanford, Wash., atomic works plant and sand blasting material for the Bureau of Reclamation, hopes to produce 62,000 tons a year at the new plant.

Two Mining Companies Sell Property

Machinery Center, Inc., of Salt Lake City has purchased the mine and mill inventory of Howe Sound Company's Holden, Wash., copper properties and the equipment and plant of Triumph Mining Co. of Blaine County, Idaho.

Howe Sound's properties were closed last June under impact of declining prices and lowering grade of ore. The company hopes to sell its community housing and other facilities to persons interested in developing the area as a recreational site. Nestled in the high mountains of the Pacific Northwest, the Holden campsite is near Lake Dompke and nine miles from Lake Chelan. At the peak of operations, some 400 families resided in the Holden area. The mine had operated for nearly 20 years.

An end to lead-silver-zinc mining in Idaho's famous Hailey district was forecast with the announcement of sale of equipment and plant by Triumph. The facilities on the property include a 300-tpd mill and mine equipment. The principle reason for selling the plant which closed last fall was the failure to develop new ore bodies. Explorations had continued for 1½ years without any major discoveries.

Joint Application for Uranium Milling Contract

United Western Minerals Co. and Golden Cycle Corp. have concluded a working agreement through which they will jointly make application to the Atomic Energy Commission at Grand Junction, Colo., for a milling contract enabling them to construct additional facilities at the Carlton Mill in the Cripple Creek District for the processing of Colorado Front Range uranium ores. Both United Western and Golden Cycle have been actively engaged in the exploration and development of leases and property in what is considered the Colorado Front Range Area for over a two-year period.

Scientists Find Metals Cover Bottom of Southeast Pacific

An oceanographic expedition to the southeast Pacific has discovered there is approximately $500,000 worth of nickel, copper and cobalt for each square mile of the ocean bottom over a large area of the Pacific.

Two research vessels of the Scripps Institution of Oceanography, on a four-month exploration in which they cruised a total of 40,000 miles between California, Tahiti and Chile, found iron-manganese nodules on the Pacific floor that contain up to one percent of each of the three commercially valuable metals. The chunks of ore contain large amounts of iron and manganese, about 30 percent of each.

ALSO . . .

The Anaconda Co. plans to curtail domestic production of copper ten percent by closing its Leonard Mine in Butte, Mont. According to Chairman Clyde E. Weed, this move is being made to bring production into balance with market requirements.

Ideal Cement Co. of Denver, Colo., hopes to complete its $12,000,000 plant near Albuquerque, N. M., early next year. The plant will have an annual capacity of 1,000,000 bbl and will employ between 100 and 200 persons. It is being built in Tijeras Canyon, where Ideal has had limestone properties for many years.

Safest "small" mine in the state of Idaho during 1957 was the Bunker Hill Company's Crescent Mine near Kellogg, according to an announcement made recently by the State Mine Inspector's office. Members of the Crescent crew won by a wide margin, with only two accidents for a total of seven days lost time reported for the year.

Merger of Vulcan Silver-Lead Corp. into Callahan Zinc-Lead Co. has been completed and the name of the new firm has been changed to Callahan Mining Corp.

Lafarge Cement of North America, Ltd., has opened a new $16,000,000 plant on Lulu Island, near Vancouver, British Columbia. The plant has an initial annual capacity of 1,500,000 bbls of cement, which can be doubled if demand merits it.

A workshop on the "Role of Industry in the American System" will be conducted at Highlands University in Las Vegas, N. M., from July 21 to August 22. This is the second year the workshop has been sponsored by Chino Mines Division of Kennecott Copper Corp. The workshop program is designed to give public school teachers, administrators, and senior college students throughout the southwest a clear over-all view of the structure and function of American business and industry.

Columbia Western Corp., a newly organized firm headed by Wayne Chandler of Cheyenne, Wyo., has filed application for a permit to build a low-temperature coal carbonization plant in that state. Carbon, Sweetwater and Laramie Counties are mentioned as the most likely sites. The proposed plant would use a process reportedly developed by the company, and will also recover fuel gas, light oil, creosote, pitch, and sulphur.

Liquidation of Northwest Uranium Mines, Inc., has been approved by the stockholders. The company's assets will be purchased by Silver Buckle Mining Co. for $2,500,000. Silver Buckle has already started preliminary work for open-pit mining operations on the low grade ore body in Stevens county, Wash.

Although sales of lead and zinc may be slow, The Bunker Hill Co. is selling all the sulfuric acid it can produce. Acid sales at the Kellogg plant are running between 8000 and 9000 tons per month. In 1954, first year of production, sales totaled only 10,000 tons, compared to 96,146 tons last year.

Initial production will be largely material to be used for guided missile components.

Consolidated Mining & Smelting Co. of Canada plans to investigate the possibilities of producing iron from iron oxide calcine—a by-product of the pyrite roasting operations at the company's Kimberly, B. C., fertilizer plant. Sintering and reduction tests are being carried out in Europe to find the best method of smelting the iron oxide calcine.

manufacturers forum

Wire Rope

EMPLOYING TWO PAIRS OF LANG LAY STRANDS and two strands of regular lay, the Herringbone wire rope is said to combine the flexibility and abrasion resistance of Lang lay rope with the stability of regular lay rope under severe operating conditions. According to the Wire Rope Division of John A. Roebling's Sons Corporation, Trenton, N. J., this rope has relatively large outside wire construction to take the pressure and abrasion of contact with sheaves and drums, combined with smaller, inside wire construction so patterned as to provide maximum flexibility in service. Test results reportedly indicate Herringbone wire rope can serve a dual purpose, eliminating the need for stocking Lang lay rope for one type of service, and regular lay rope for others.

Vulcanizing Press for Electric Cable

FOR REINSULATING and rejacketing natural rubber, synthetic rubber and thermoplastic covered cables, Joy Manufacturing Co., Pittsburgh, Pa., has announced the completion of a new line of molding presses. Reputed to accommodate all standard cable types and sizes through the use of interchangeable aluminum molds, these presses carry a 3000-watt rating and are currently available for operation on seven standard a-c and d-c voltages. Heat from four replaceable strip heaters (two in the top and two in the bottom platen) is applied directly through molds to areas being vulcanized at molding pressures of up to 25 tons. This departure from old designs employs twin tie bars that can be dropped for front loading and permit using press to create Y and T splices.

Measuring 18⅛ in. long by 18¾ in. high and 13-in. deep, these vulcanizers accommodate rectangular shaped molds up to 6 by 6 by 24 in. and can be used in tandem (end to end) for making longer cable repairs. Weight, less molds, is approximately 85 lb.

Additional information is available in Flyer F47, which may be obtained by writing Department A-68, Joy Manufacturing Co., Electrical Products Division, 1201 Macklind Ave., St. Louis 10, Mo.

Clamshell Buckets

ALUMINUM has been introduced by The Owen Bucket Co., 6001 Breakwater Ave., Cleveland 2, Ohio, into the construction of power crane clamshell buckets for the handling of coal and other free-flowing materials.

Use of aluminum in buckets of three to ten cu yd capacity has the advantage of reducing the dead weight of the bucket, thereby reducing the load on the crane.

In the design of the lightweight bucket, Owen reportedly has incorporated other features to minimize wear and strain on parts, and on the crane on which it is mounted. Tandem positioning of the lower closing sheaves permits the closing line lead to function in the center plane of the bucket. This center-line reeving is said to eliminate bending of the cable at the guide rollers as the bucket is hoisted, thus increasing the life of the cable.

Cutting edges, corners and other surfaces exposed to rough treatment are made of steel to withstand the abuse to which the bucket is subjected when working in railroad cars, barges and boats.

These aluminum buckets are individually designed to meet specific job requirements.

Inquiries about new equipment appearing in Manufacturers Forum are welcomed. For additional information on any piece of equipment in this section write directly to the manufacturer, or to Mining Congress Journal with name of item and date of issue in which it appeared.

Continuous Cleaning Feature Added to Drill

TO PROVIDE CONTINUOUS HOLE CLEANING AIR, the Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y., has made a design change to the Depthmaster "down-the-hole" drill. The manufacturer claims that constant hole cleaning air is available to keep the hole clean and the drill free even when it is necessary to stop drilling operations for any reason. All operating air is exhausted through the bit and, therefore, is used for hole cleaning. The firm claims this exclusive, patented feature eliminates the need for special exhaust ports in the side walls of the cylinder which can let harmful cuttings into the drill. This drill is manufactured in three sizes for blast holes from 4¾ to 7 in. The manufacturer also states that the drill is available to users of other drilling equipment.

Transmitter-Receiver

A SINGLE-SIDE BAND commercial transmitter-receiver has been developed by Barker & Williamson, Inc., Department 31, Bristol, Pa. This transceiver is intended for use in the high frequency range of 2.4 to 20 megacycles for commercial point-to-point or mobile service wherever the advantages of single-side band can be utilized.

The transmitter-receiver is adaptable to various methods of operation. It is normally used as a radio telephone. With accessories, the unit can be adapted to radio teletype transmission with as many as four receiving and transmitting channels. It is possible to use a selective calling system where a number of stations share a common frequency and where it is inconvenient to monitor continuously for incoming calls. The SSB-200 can also be operated from a central telephone switchboard, or with remote telephone units.

NOW CARBURIZED DRILL STEEL life that is

MEASURED IN MILES*

on the job performance proves lower cost per foot of hole when you use the ALL I-R Deep Hole Drilling Combination

* More than *6 miles* of hole with a single steel! That's the record chalked up by an I-R Carburized Alloy Steel Rod on a Montana construction project. This "super" steel broke after 32,307 feet. Another piece broke at 24,400 ft. and another at 15,000 ft. Performance like this on hard rock, deep hole drilling jobs is the result of Ingersoll-Rands improved Carburizing process. Every steel is specially treated to provide exactly the *right combination hardness* and *core toughness* to withstand billions of heavy impacts without molecular fatigue.

And what about *bit* performance? On the same job, in hard basalt, customer keeping accurate records reported an I-R Carset bit that drilled 4,065 feet on *one* regrind. On second regrind insert still looked good with considerable footage left in the bit. Bits used were I-R non-rifling type 60X face design available in 2½", 2¾", 3" and 3½" sizes.

This is further evidence that it *pays* to use the ALL I-R Deep Hole Drilling Combination.

Carburized Shank Piece gives extra strength and wear resistance where it is needed most.

Semi-Bridge Couplings assure proper alignment between sections—permit deep hole drilling without pulling steels.

Also CARSET BITS with Type 40 or Quick-Change I-R Type 22 Threads

Inserts, shoulder, clearance, and skirt all correctly designed for highest sustained drilling speed and maximum bit life. Available with either the Type 40 Thread or with the Quick-Change Type 22 Thread, especially designed for faster and easier detachability.

Thread	Description	Bit Sizes	Net Weight Lb.	Net Weight Oz.
Type 40	1¼" O.D. Thread, 3½ threads per inch	2"	1	2
		2⅛"	1	5
		2¼"	1	8
Type 22	1¼" O.D. Thread, 3 threads per inch	2"	1	2
		2⅛"	1	5
		2¼"	1	8

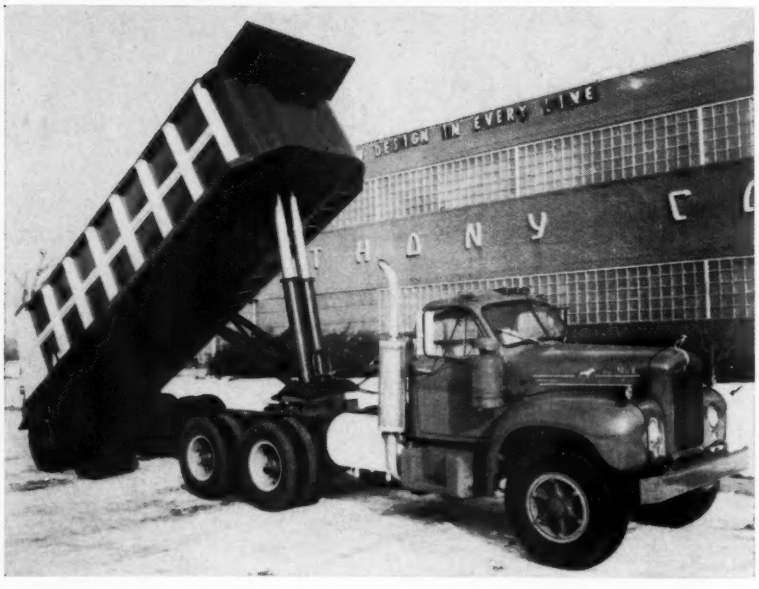
For complete information, or for an eye-opening trial order, call your Ingersoll-Rand man as soon as you can.

Ingersoll-Rand

15-941 11 Broadway, New York 4, N.Y.

A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR DRILLING ROCK

Dump Trailer



WEIGHING 16,880 POUNDS, the Frameless Excavator's dump trailer introduced by Anthony Co., Streator, Ill., is the largest unit in the company's Frameless Trailer line. Individual models of capacities to meet job requirements range from 20 to 24 ft in length.

In order to provide easier unloading, the body width is tapered. The rub rail, or running board, is slanted to prevent material from being carried on the outside of the body. The trailer is built of eight-gauge steel and has ¼-in. wear plate. In addition, the unit is said to have extra-heavy boxed top roll and horizontal braces, a reinforced cylinder well, 42,000-lb tandem suspension, 16½ by 7 air brakes, and 11:00 by 20 14-ply tires.

Dump action is provided by a twin seven-in. Teleramic hydraulic telescopic hoist having a lifting capacity of 40 tons. Trailers equipped with hoists having capacities up to 50 tons are available.

Diamond Core Drill

DESIGNED FOR ONE-MAN OPERATION in underground exploratory work, this air powered drill unit can be carried and operated by one man anywhere within reach of the mine air supply, according to the Diamond Drill Contracting Co. of Spokane, Wash. Drilling pressure is provided by a hand-operated hydraulic feed cylinder. Five lb pump handle pressure delivers 1000 lb pressure on the bit. Drilling depths of at least 60 ft can be reasonably expected in hardest rock formation, and 100 ft or more with over 90 percent core recovery is not uncommon under normal drilling conditions, according to the manufacturer. The unit drills in any direction or at any angle in drifts, stopes, or raises.

Called the Super Scout, the unit consists of drill, hydraulic feed cylinder and an anchor column which provides drill support at any angle. Total weight is 85 lb. Hole size is $1\frac{3}{16}$ in. with an $1\frac{1}{16}$ in. core. The drill is powered by a two hp air motor and includes water swivel and chuck.

Welding Helmet-Sound Protector

A COMBINATION welding helmet-sound protector has been announced by the American Optical Co., Safety Products Division, Southbridge, Mass. This model was developed to protect welders who work where there is exceptional noise.

The sound protector unit has elongated-type ear domes which cover the jawbone opening and protect against high and low frequency noises. Ear domes swivel to fit the head and vinyl sponge ear seals fit securely. According to the company, a perfect seal is possible even when worn over personal or safety Rx glasses. Neoprene covered spring headband is attached to the sides of the helmet by spring-type friction joints. Vinyl foam ear puffs may be removed and replaced for sterilization. Conversation and signals are audible for maximum safety.

The welding helmet, made of fiber glass, is said to be moisture-proof and well ventilated. The entire unit is claimed fireproof and rust proof.

Motors

A LINE OF CAPACITOR-START induction-run single phase integral horsepower motors designed to provide high starting torque and operating efficiency has been announced by Fairbanks, Morse & Co. The motors are said to be especially suited to the severe conditions and high starting torque required for service with: pumps, fans, drill presses, lathes, sanders, circular saws, brine agitators, pulp grinders and similar equipment. Type WCZK single-phase 60-cycle, 115/230 volt motors are available from ¾ hp to 1½ hp at 1200 rpm, 1 hp to 3 hp at 1800 rpm, and 1½ hp to 5 hp at 3600 rpm.

Drill

DESIGNED TO DO AUGERING, core drilling and large diameter earth boring, the B-40 Explorer is self-powered by a four-cylinder, 36-hp air-cooled engine. It is also available without engine for mounting on any PTO-equipped truck, barge or tractor.

Mounting dimensions for drill assembly are: length 37½ in., width 26½ in., height 55 in. (tower down) and 86¼ in. (tower up); for power assembly: length 45½ in., width 26½ in., height 40 in.

The B-40 reportedly is used for continuous flight augering to 75 ft, for coring to 500 ft, and for boring holes up to 24 in. in diameter. Drilling speed rages from 62 to 500 rpm with maximum torque output of 1740 ft lb. The 68-in. stroke is actuated by hydraulic cylinder exerting 7069 lb lift pressure, 6283 lb ram pressure. Rate of free feed is 35.3 fpm. Centralized controls permit one-man operation.

For complete details and specifications write Mobile Drilling, Inc., Dept. 31, 960 N. Pennsylvania St., Indianapolis, Ind.

Portable pH Meter

WEIGHING TWO POUNDS, the pocket pH Meter reportedly speeds pH control of mining and ore flotation process. The portable instrument is said to be useful, for example, in checking pH of ore processing and boiler waters, and in determining the amount of acid or alkali to add to the "frother" when adjusting pH to the optimum value for flotation.

Powered by six small batteries, the instrument has a range of 2-12 pH—readable to 0.1 pH. It has a corrosion-resistant plastic case and a combination glass and reference electrode with a 36-in. lead. The electrode clamps to the instrument's side, and can be used in this position when lead-length is not desired.

For further information write Beckman/Scientific Instruments Division, Fullerton, Calif.

Coal Firm Develops New Roller Conveyor

A ROLLER CONVEYOR developed by The United Electric Coal Companies of Chicago for use on the Kolbe excavating wheel has recently been granted U. S. patents, according to an announcement by Frank F. Kolbe, president. Tested for more than two years, this roller conveyor reportedly is now operating successfully on a Kolbe wheel excavator at Buckheart mine near Canton, Ill. Material from the digging wheel flows onto the roller conveyor which discharges it to a belt conveyor. The new roller conveyor is said to handle up to 100 percent more material within the same discharge area through which the material passes.

According to Kolbe, tests demonstrate that the new roller conveyor has solved one of the major operating problems—the difficulty of discharging material from the wheel to the conveyor belt in a side-loading operation. The conveyor can handle efficiently a larger tonnage from a wider wheel. By control of roller speed, it is possible to regulate side loading of material to the center of the belt to eliminate spillage. It operates as a self-cleaning mechanism, eliminating slope sheet cleaners used with former devices.

MSA Buys Controls of German Firm

A CONTROLLING INTEREST in the Auergesellschaft Aktiengesellschaft (Auer Co., Inc.) was recently purchased by the Mine Safety Appliances Co. of Pittsburgh, Pa. The sale, made by Degussa Frankfurt, Main, to M.S.A. covers the entire manufacturing facilities of Auergesellschaft located in West Berlin and Schwabisch Gmund. Auergesellschaft manufactures a complete line of gas masks, carbon monoxide and duct respirators, inhalators and oxygen breathing apparatus. One of the oldest producers in Gemany of gaslight equipment, the company also manufactures luminous chemicals and X-ray accessories.

Auer will operate as a subsidiary company under Mine Safety Appliances' mining-international group which is headed by C. M. Donahue, vice president.

A company official said the purchase gives MSA extensive manufacturing capacity in Europe which will be utilized in serving the expanding market for safety equipment within Germany and the Common Market.

Tractor-Loader

DESIGNED TO LOAD AND TRANSPORT ore in underground mines, the Wagner Mucker's low-slung construction is said to aid maneuverability and production in loading out ore. All parts of the Mucker (including the 1¼-yd capacity bucket, when in loading and carrying position) are lower than the top of the tires. The unit has four-wheel drive and four-wheel steering, free oscillation of both axles, planetary drive and hydraulic power steering.

Inquiries should be directed to Wagner Tractor, Inc., P. O. Box 7444, Portland 20, Oreg.

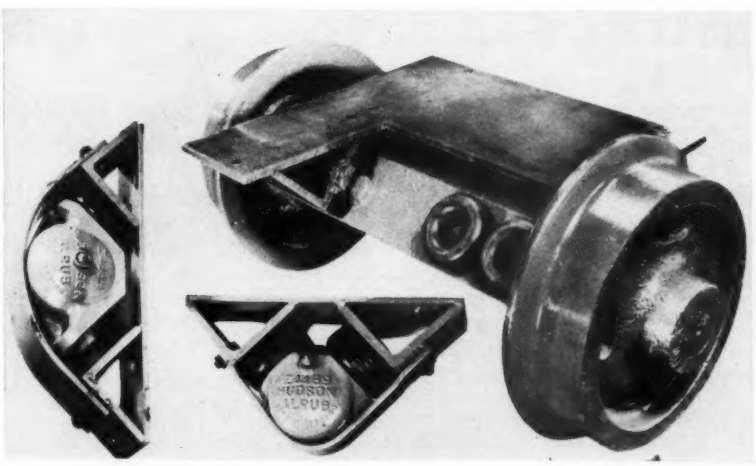
Blasting Agent

A SMALL-DIAMETER Accomite Blasting Agent, said to be particularly suitable for limestone mining has been announced by the American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y. The new Accomite has a minimum diameter of 1½ in. and a length of 16 in., and is a non-nitroglycerine blasting agent. In this size, the explosive has a cartridge count of 45 per 50 lb. The fume classification is said to be rated good and the water resistance as poor. It is insensitive to a No. 8 electric blasting cap and thus required the use of a primer. It is important, the company said, that compaction and column continuity be achieved in the borehole.

Jaw Crusher

WITH A 30 BY 42 IN. FEED OPENING, the latest edition to Eagle's line of crushers has a rated capacity of 125 to 400 tph. Over-all weight of jaw crusher alone is 55,000 lb. The unit requires a 125-150 hp motor to attain and hold normal operating speed of 200 rpm and has a 58-in. fly-wheel and reversible jaws of manganese steel. Safety toggle seat of Pitman is replaceable and crusher jaws are adjustable (while operating) from a minimum of ½ in. to a maximum of 8 in.

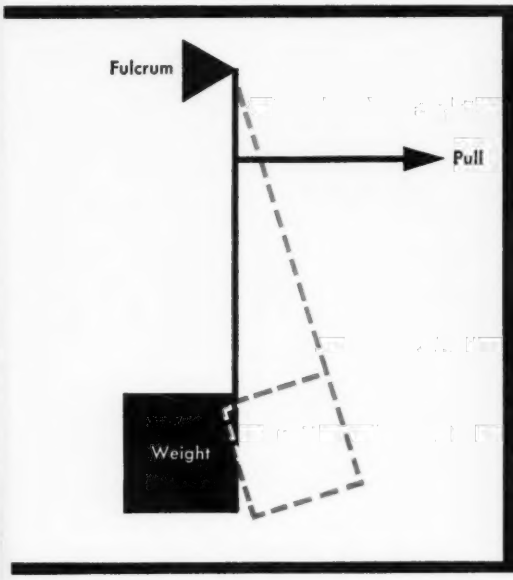
Rubber Suspension for Mining Cars

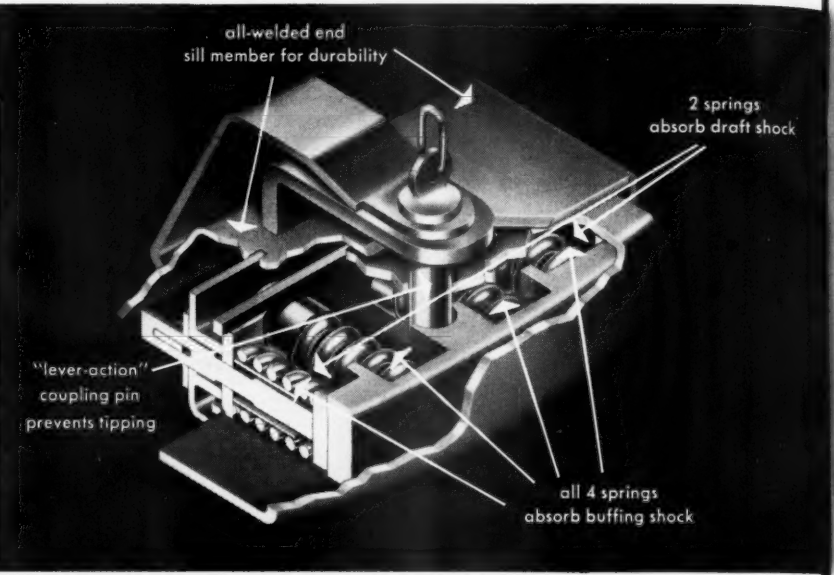


TO OFFSET COIL SPRING BREAKAGE caused by corrosion and metal-to-metal wear, a rubber suspension has been developed. This type of springing is in the form of natural rubber rings which isolate the axle box from the rest of the chassis except on a rebound, and provide resilience fore, aft and laterally, as well as vertically. Rings capable of handling loads up to 7500 lbs per pair are now available. For heavier loads, rings mounted abreast on suitable bearings can be used.

This type of mine car suspension is fully described and illustrated in the current issue of *Rubber Developments*. For a free copy write the Natural Rubber Bureau, 1631 K Street, N. W., Washington 6, D. C.

TAKE THE SHOCK OUT OF YOUR MINE CAR TRIPS!





acf HEAVY DUTY DOUBLE-ACTION SPRING BUMPER

✓ **Permits starting and hauling longer car trips!**

✓ **Extends car life, lowers maintenance and repair costs!**

✓ **Cannot tip, flatten or crush under severe draft or buffing force!**

✓ **Proved in fifteen years of service on thousands of cars!**

acf's exclusive spring bumper assembly soaks up draft and buffing shocks with ease, adds years of trouble-free life to mine car structure even in the hardest service! No other "shock absorber" works as well.
Available on all sizes and types of **acf** mine cars: end dump, rotary dump, or drop bottom. Fits neatly into the exclusive **acf** all-welded end sill member. Spring sizes varied to suit car design and capacity. A representative will be glad to explain the advantages and engineering features of the time-proven **acf** Double-Action Spring Bumper. Get in touch with your nearest **acf** sales office, or write Dept. MC-7 in New York.

Bulletin describing all types of **acf** Mine Cars available on request.

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MINE CARS FOR CONSTANT HAULAGE

SALES OFFICES: New York • Chicago • Cleveland • Washington, D. C. • Philadelphia • San Francisco • St. Louis • Berwick, Pa. • Huntington, W. Va.

Conveyor Belt

A MEDIUM WEIGHT, double duty belt, the Shockmaster was specifically designed to allow the belt to be turned over after the first carrying side is no longer satisfactory. Thus, both top and bottom carrying surfaces reportedly can be utilized.

Shockmaster is made of two or three-ply heavy cotton nylon fabric with a skim coat of rubber between plies. An envelope ply of frictioned, double skimmed, extra heavy open weave all nylon fabric, entirely encompasses the core and acts as a cushion. The top and bottom covers are made of abrasion resistant rubber, 3/32 in. thick.

The belt will handle all types of material which Quaker's Ebonite brand handles with the added advantages of increased flexibility, impact resistance and extended life. It is said to be particulary advantageous in applications where 45° idlers are necessary on narrow belting.

Samples of this belt and more detailed technical information are available upon request by writing to the Quaker Rubber Division, H. K. Porter Co., Inc., Tacony & Comly Streets, Philadelphia 24, Pa.

Roof Bolt Recovery Jack

WITH A 24-IN. RACK BAR TRAVEL, the Simplex M279 roof bolt recovery jack weighs 36 lb for a 72-in. minimum jack size. Column and all castings are made of aluminum alloy. For more information, write to Templeton-Kenly & Co., 2535 Gardner Rd., Broadview, Ill.

Dust Collecting Stoper

WITH TELESCOPIC FEED and a dust collecting system approved by the Bureau of Mines, the S12VT stoper is available in two feed lengths, 34 in. and 52 in. Over-all closed lengths are 25½ in. and 34½ in.; over-all extended lengths are 59½ in. and 86½ in. Steel changes are 30 in. and 48 in.

The dust collector tank required with the stoper is the Le Roi DK288, a vacuum pressure dust collector which has the Bureau of Mines approval No. BM2135. When used with required steel and bits, either CRD Vac-Nu-Matic or CRD five-hole bits, dustless drilling reportedly can be done with a minimum amount of wear to stoper parts.

Drill steel required is ⅞ in. hexagon with a ⅜ in. diameter hole. Hose and air connections are ¾ in. Air consumption is said to be 120 cfm. Weight of the stoper is 92 lb for the 34-in. feed and 98 lb for the 52-in. feed.

Additional information and specifications may be obtained by writing to the Sales Promotion Department, Le Roi Division, Westinghouse Air Brake Co., Milwaukee 1, Wis.

Clamshell Attachment

WITH FIVE DIFFERENT BUCKET WIDTHS, a clamshell attachment for the Speed Swing Loader has been announced by Pettibone Mulliken Corp., 4700 W. Division St., Chicago 51, Ill. Maximum dumping height of the attachment is nine ft and maximum digging depth is ten ft. Buckets for digging rock and dirt are available in 18 and 24 in. widths. For handling light materials, such as slag and coal, 30- and 36-in. buckets are available. Sixty-in. buckets for handling rubbish and snow are also available.

—*Announcements*—

James William Forman has been promoted to sales manager of the **Fairmont Machinery Co.**

Forman, formerly service and preparation engineer, succeeds **Vause R. Graves**, who now becomes manager of coal preparation.

Bird Machine Co. has elected **Calvin A. King** first vice president and **Henry H. Shepherd** vice president in charge of sales.

Gordon MacVean, president, **National Mine Service Co.**, and **Charles E. Manning, Jr.**, president, **Charles E. Manning Co.**, have announced an agreement whereby National Mine Service will become a stocking distributor for Alumiron couplings and fittings, a Manning product.

George P. Lacy has been appointed vice president and general sales manager of wire and wire rope products at **Union Wire Rope Corp.**, subsidiary of Armco Steel Corp.

L. G. Schraub, who had been vice president and general sales manager since 1938, has retired from active duty with the company. He will continue however on a consulting basis.

George E. Clark, president of **The Adams Express Co.**, has been elected a director of **Joy Manufacturing Co.**

Don Rose, for many years general counsel and a member of the board of directors of Joy, requested his retirement from both positions. **Evans Rose**, managing partner of the law firm of Rose, Rose and Houston, was elected general counsel and director to succeed his father.

Austin Goodyear, executive vice president of **Hewitt-Robins, Inc.**, has been elected president of the company, succeeding **Thomas Robins, Jr.**, who has held the dual positions of chairman of the board and president. Robins will continue as chairman of the board and chief executive officer.

A branch office of the **Ellicott Machine Corp.**, dredge manufacturers, has been opened in Room 507, Underwood Building, 525 Market Street, San Francisco, Calif. In charge of this office for sales, engineering and field service on dredges of all types is **Charles M. Romanowitz**, formerly director of sales for the **Yuba Manufacturing Co.**

(Catalogs & Bulletin next page)

CATALOGS & BULLETINS

PIPE FITTINGS AND SUPPLIES FOR HYDRAULIC MATERIAL HANDLING. *Meckum Engineering, Inc., Dayton Road, Ottawa, Ill.* Compiled as a convenience to the hydraulic pump operator, Bulletin No. 600 presents a condensed list of fittings and supplies. Pipe, fittings, hose and the many other items used by the pump operator are listed in the most commonly accepted range of sizes, from 6 to 20 in.

WIRE ROPE. *Advertising Dept., Leschen Wire Rope Division, H. K. Porter Co., Inc., 2727 Hamilton Ave., St. Louis 12, Mo.* Service life of wire rope can be extended by eliminating excessive localized wear and damage, according to Leschen Red-Strand Service Bulletin No. 106. It points out that users frequently discard lengths of otherwise serviceable rope because of localized damage. The bulletin lists causes of these conditions and suggests corrections that will extend service life.

REAR AXLES. *Consumer Relations Department, International Harvester Co., 180 North Michigan Ave., Chicago 1, Ill.* Form CR-320-H describes a line of International truck-built heavy-duty rear axles. The axles, both single reduction and two-speed, are said to be designed specifically for handling from 50,000 lb up to the maximum gross combination weights permitted by legal limitations for tractor-trailer highway operations in any state, and up to 30,000 lb gross vehicle weights for off-highway applications. Rated load capacities of the axle huosings are 18,500 and 23,000 lb. The axles are available in a wide range of heavy-duty International truck model series.

PORTABLE DRILLING EQUIPMENT. *Davey Compressor Co., Kent, Ohio.* Descriptive of Davey's complete line of portable rotary drilling equipment, Form E-270 includes over-all rig photos, sectional views of individual operating mechanisms and action pictures. Complete specifications are presented on six standard rotary drills. These include an air blast unit, a mud fluid rig and four combination air compressor - mud pump machines.

CUTTING EDGES FOR BULLDOZERS, SCRAPERS. *Advertising Division of Caterpillar Tractor Co., Peoria, Ill.* How well a cutting edge performs depends on its ability to resist wear, bending and breakage. An eight-page bulletin entitled, "Hi-Electro Hardened Cutting Edges," points up the features of these recently developed parts for scrapers and bulldozers. Illustrated throughout with photographs and drawings, Form DE804 describes the phases of testing and manufacting necessary to develop the Hi-Electro hardened edges.

METAL STITCHING, A NEW IDEA IN FASTENING. *Acme Steel Co., 135th St. & Perry Ave., Chicago 27, Ill.* The booklet gives detailed information on stitching metal to metal or metal to nonmetallic materials and illustrates several applications.

INDUSTRIAL RUBBER PRODUCTS. *Acme Rubber Mfg. Co., Advertising Department, Trenton 3, N. J.* The 72-page catalog includes industrial rubber products used by the construction, manufacturing, mining, petroleum, agricultural and processing industries. It describes and illustrates 32 types of hose, eight types of conveyor belting, six types of packing, plastic pipe, garden hose, and couplings. Information on applications, product construction and lengths available is included, along with specifications listing diameters, working pressures, weights and plies.

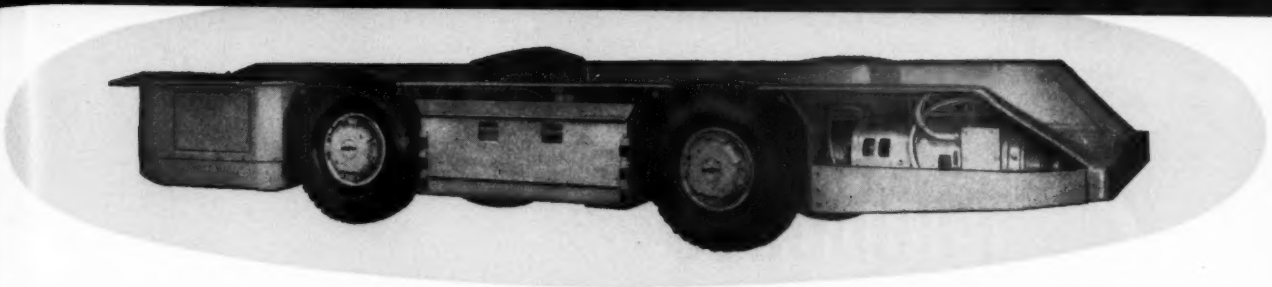
TRACTOR SHOVEL. *Construction Machinery Division, Allis-Chalmers Mfg. Co., Milwaukee, Wis.* Illustrated catalog (MS-1234) covers the design, engineering, construction and operating features of the Allis-Chalmers HD-6G tractor shovel. The brochure also includes the HD-6G's specifications and a list of the interchangeable attachments that are available to increase the versatility of the unit.

USE AND CARE OF WIRE ROPE. *Wire Rope Corporation of America, St. Joseph, Mo.* Written as an information piece for everyone who buys, sells or uses wire rope, the book explains how to select the right rope for specific needs; methods of socketing, splicing and installation and important points on safety.

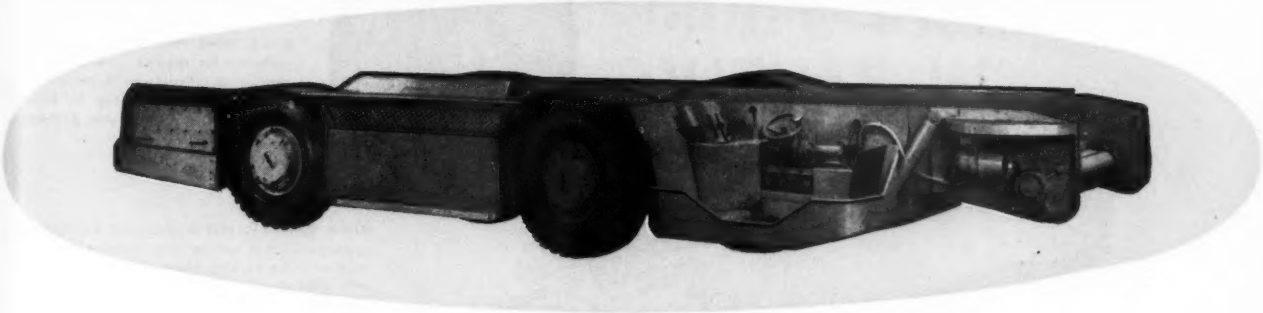
CLASSIFIER. *Hardinge Co., Inc., York, Pa.* Bulletin AH-478 describes the "Overdrain" Classifier, said to be a new device in the field of belt-type wet classifiers. The belt, with lifting flights attached beneath, moves upwardly out of the sand bed between two stationary side shrouds—creating the effect of a series of moving, closed, washing compartments. The only outlet from these compartments is via holes in the belt above. Surplus liquids and slimes discharge through these "overdrain" holes without mixing with the oncoming sands.

GENERAL UTILITY PUMP NOZZLES. *Jordan Industrial Sales Division of OPW Corp., 6013 Wiehe Road, Cincinnati 13, Ohio.* The improved OPW-Jordan general utility Dispensing Nozzles 12 and 12-A now incorporate dash-pot control for shockless closing, according to Bulletin NP-27. The nozzles reportedly can be closed suddenly without causing line shock, bursting hose, or pump damage and are available in a high tensile aluminum, and bronze, in 3/4 and 1-in. sizes.

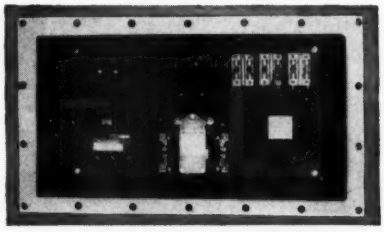
Index to Advertisers



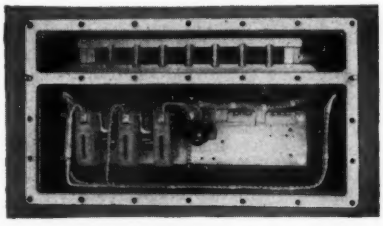
NOW, TORKAR* *economy* FOR THIN SEAMS



The NEW National Mine TorKar Type 30 A. C. or D. C. Shuttle Car



A. C. Control Panel



D. C. Control Panel

(with resistors and drilled to accommodate Ground Sentinel, if specified)

The maintenance and performance standards set by the Type 48 TorKar during the past five years now can be realized in thin seam operations. The new Type 30 TorKar (height from 30 to 36 inches) has the rugged body construction and all of the design features of the larger car. These include single A. C. or D. C. motor, efficient torque converter, three speed forward-and-reverse transmission, high-speed unloading, simplified wiring and electrical control, four-wheel drive and steering, interchangeable heavy-duty wheel units, and zoned or automatic lubrication.

For complete information on these remarkable new TorKars, consult your National Mine representative or write.

SPECIFICATIONS — Model 30

Motor: 17½ hp, A.C., 15 hp, D.C.
Base height without sideboards: 30 in.
Length with medium boom: 22 ft. 5¾ in.
Width: 95⅜ in.
Tire Size: 7.00/15
Tramming speed loaded m.p.h.: low, 1.68; second, 2.73; high 4.25
Capacity level full, cu. ft.: without sideboards, 105
Capacity level full, cu. ft.: with 6" sideboards, 154

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National Mine Service Company

National Mine Service Company

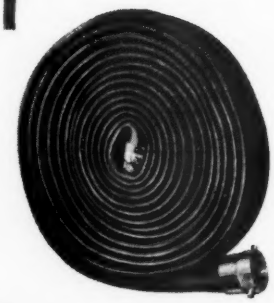
Alcoa Building • Pittsburgh 19, Pennsylvania

Exclusive Distributor

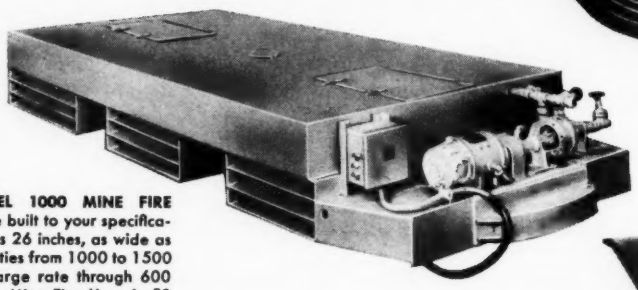
ALL-STATE DIVISION Logan, W. Va. | ANTHRACITE DIVISION Forty Fort, Pa. | ASHLAND DIVISION Ashland, Ky. | BEMECO DIVISION Beckley, W. Va. | CLARKSON DIVISION Nashville, Ill.

GREENSBURG DIVISION Greensburg, Pa. | KY.-VA. DIVISION Jenkins, Ky. | MOUNTAINEER DIVISION Morgantown, W. Va. | WESTERN KY. DIVISION Madisonville, Ky. | WHITEMAN DIVISION Indiana, Pa.

THESE MSA PRODUCTS HELP YOU FIGHT MINE FIRES INSTANTLY

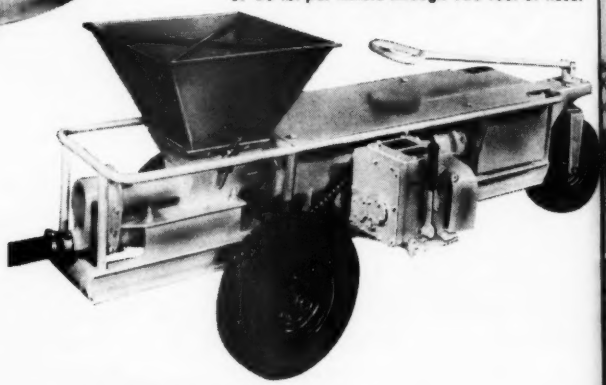


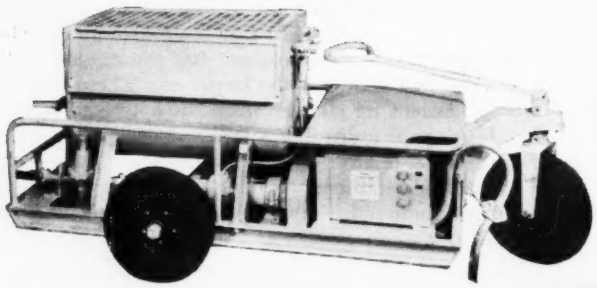
M-S-A MINE FIRE HOSE is especiall designed for rugged mine use. It's im pervious to rot and vermin. Never need drying. Lightweight. Easy to handle Dated and branded for your protection



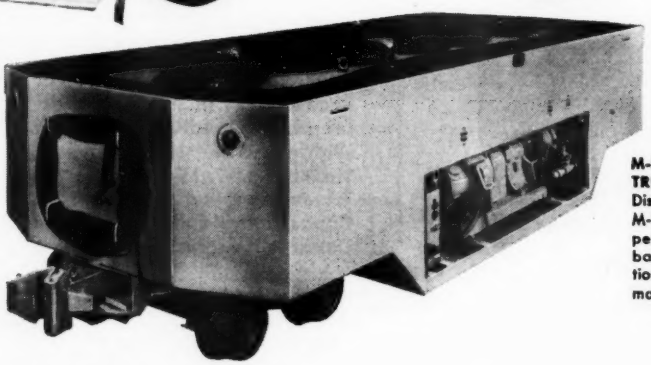
M-S-A MODEL 1000 MINE FIRE TRUCK can be built to your specifications: as low as 26 inches, as wide as 7 feet. Capacities from 1000 to 1500 gallons. Discharge rate through 600 feet of M-S-A Mine Fire Hose is 50 gallons per minute at 50 psi.

M-S-A BANTAM 400 ROCKDUST DISTRIBUTO applies rockdust wet or dry. Availability of th machine in the working place, and the men's famili arity with its operation, make it ideal for fightin fires at their inception. Discharges dry dust throug as much as 400 feet of hose at an average o 30 lb. per minute. Discharges wet dust at a rat of 50 lb. per minute through 150 feet of hose.





M-S-A SLURRY ROCK DUST DISTRIBUTOR can pump a slurry of rockdust and water—the cheapest fire-fighting agents for mine fires—through as much as 1000 feet of hose at the rate of 120 lb. per minute.



M-S-A MODEL 2100 MINE FIR TRUCK has 2100-gallon capacity Discharge rate through 600 ft. o M-S-A Mine Fire Hose is 91 gallons per minute at 150 psi. Tank is fully baffled with triple weld construc tion. Truck is designed for easy maneuverability.

Any delay in fighting a fire may prove disastrous. Often, the sealing of an entire mine or section results. Such an operation is not only hazardous. It's costly.

This threat to human lives and vital mining equipment, however, can be greatly reduced. You can do it with one or more of the indispensable items described above.

A minimum investment in MSA fire-fighting equipment *now*, may save you thousands of dollars later. Write us for helpful literature.

MSA
SAFETY EQUIPMENT HEADQUARTERS

MINE SAFETY APPLIANCES COMPANY
201 North Braddock Avenue, Pittsburgh 8, Pennsylvania

MINE SAFETY APPLIANCES CO. OF CANADA, LIMITED
Toronto, Calgary, Edmonton, Montreal, Sydney, Vancouver, Winnipeg

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